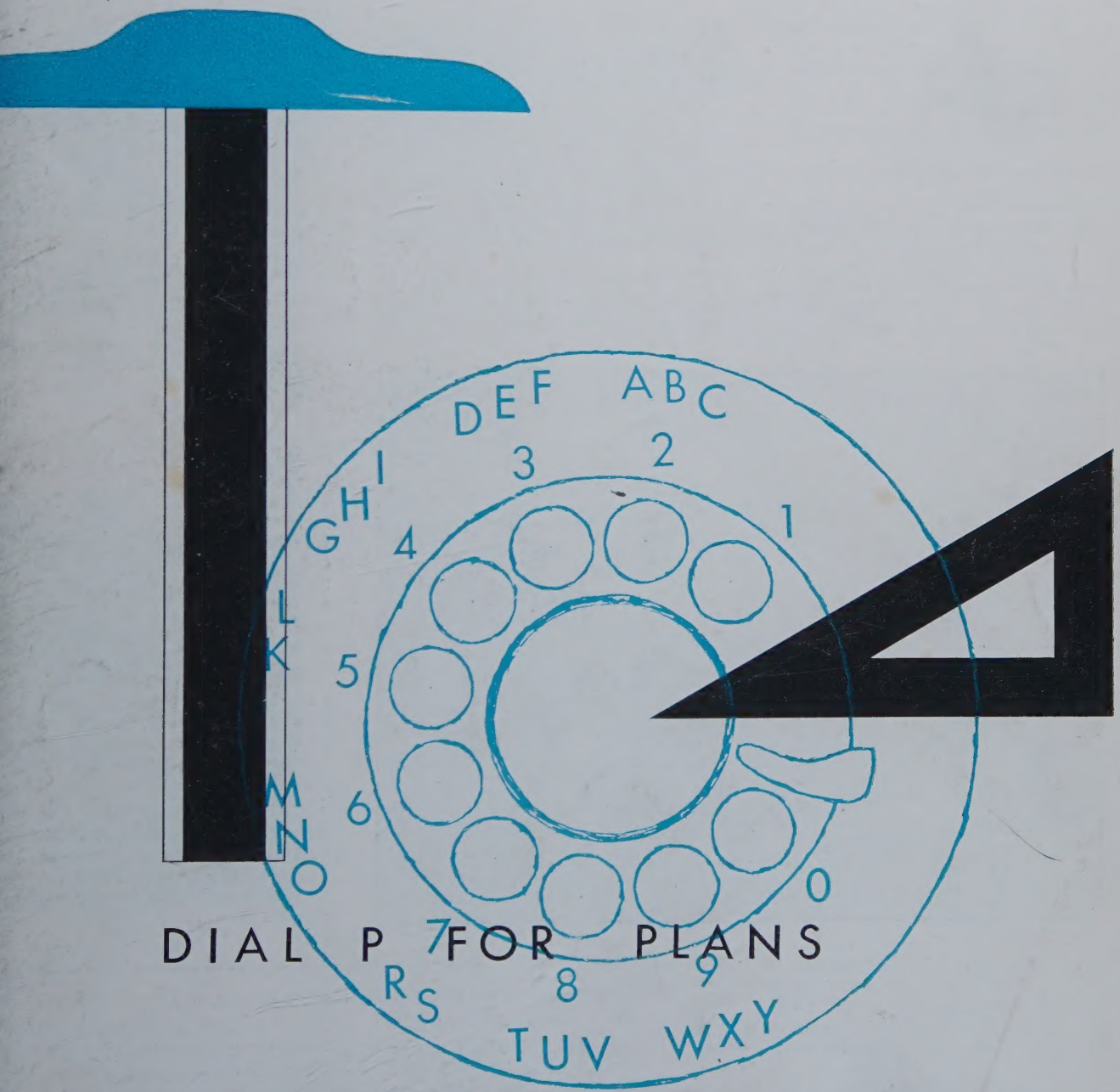
GRAPHIC SCIENCE

THE MAGAZINE FOR DRAFTSMEN



DIAL P FOR PLANS

OBER 1959

Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.

One of the ways to judge a skilled craftsman is by the tools he uses. They're invariably the best he can find – chosen to lighten his work, sharpen his skills. And, if the craftsman is a draftsman, they are, more often than not, products of K&E.

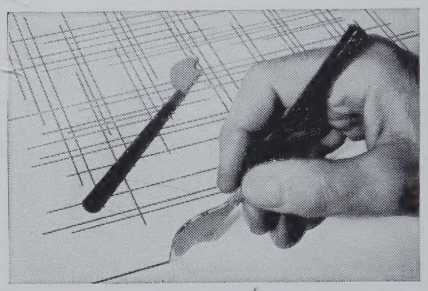
It may be that some of these products have escaped your attention (after all, we offer something over 8000 items). That's why we suggest you pay a visit to your K&E dealer whenever you can. It's a liberal education on what's new – as well as what's tried and true – in drafting equipment.

You'll find many products like these which can be highly useful in your work . . .

K&E "Quick Set" Bow Compass

The most remarkable feature of this compass is the speed and ease with which you can change settings–from diameters of 12 inches to 1/16 inch. With one hand, you can increase or decrease radii instantly and exactly. To go from small to larger radius, just press a spring release, and the legs will expand automatically. Stop approximately where you want, and make precise adjustments with a micrometer screw. To go from large to small, simply squeeze the legs of the compass together, then adjust precisely.

The K&E Quick Set combines the rigidity and precise adjustment of a standard bow compass, the simplicity and speed of a friction type compass, plus the finger tip control of K&E's unique design. You have to try the Quick Set to appreciate it fully. Two types are available. The N1071 fixed leg pencil compass, and the N1070 combination with interchangeable pen and pencil inserts. Both come with a box containing leads and spare needles. And with the N1070, a pen handle is provided for the pen insert which permits its use as a ruling pen. The compass can also be used as a divider by substituting one of the spare needle points for the lead in the pencil insert.

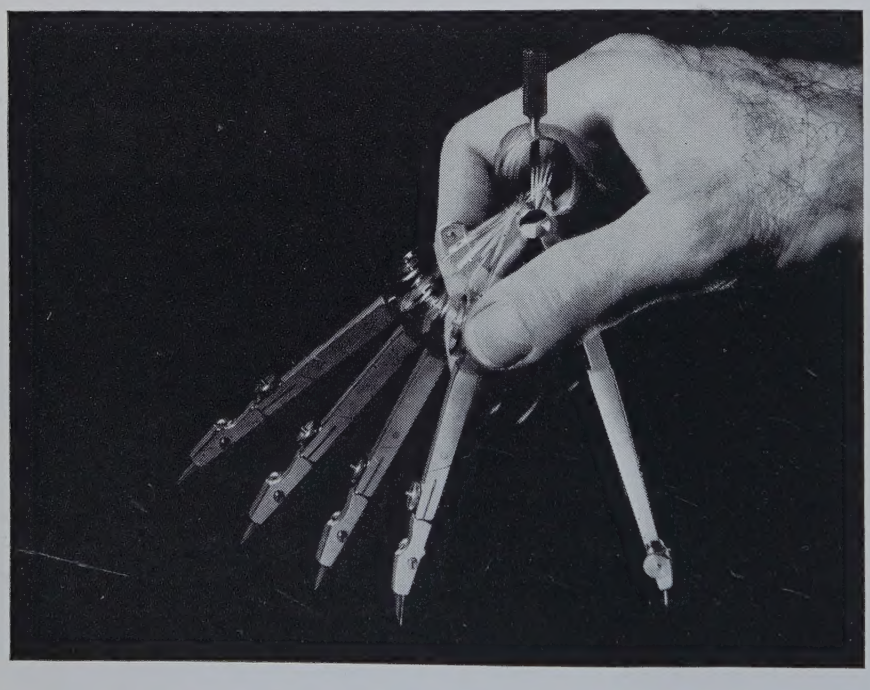


Marathon® Ruling Pens

K&E Marathon Long Line and Wide Line Ruling Pens (1092) hold an extra large ink supply – draw lines up to eight times longer than ordinary ruling pens. And because they are pre-set, line widths are always uniform, easy to match with complete accuracy. Ink flow is regular and even, lines are always sharp and clean edged.

An important feature of K&E Marathon Ruling Pens is that they will *not leak*. They can be laid on the work surface without risk of ink flowing out. That means you can fill several pens of different widths and use them as freely as you'd use pencils. They're easy to clean, too.

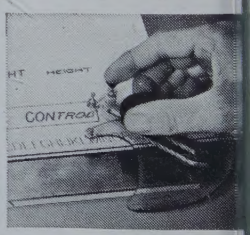
K&E Marathon Long Line Ruling Pens are available individually in line widths of .006, .009, .013, .020 inch – or in sets of three pens in line widths of .009, .013, .020 inch in a Leatherite case. Marathon *Wide Line* Ruling Pens come in line widths of .030 and .060 inch.



Leroy® Height and Slant Control Scriber

A versatile new Leroy scriber is now available which greatly expands the variety of lettering possible from a standard Leroy template.

Now, with the new Height and Slant Control Scriber (3237-12), you can form characters from vertical to slanting at any angle up to 45° forward. You can vary height from 60% to 150% of the size of letters on the template used. The width of letters remains the same.



Combinations of height and slant can be set quickly and easily. You just loosen the knob, move the scriber arm to the desired combination of height and slant, and tighten. That's all there is to it.

Stop in to see your nearest K&E dealer and ask to see these three products—small, perhaps, but mighty handy in the drafting room. Or drop us a line by mailing the coupon below . . .

KEUFFEL & ESSER CO., Dept. GS-10, Hoboken, N. J.

I'd like more information on:

- ☐ K&E Quick Set Compass
- ☐ Marathon Ruling Pens
- ☐ Leroy Height and Slant Control Scriber
- ☐ Please send me the name and address of my nearest K&E Dealer.

Name & Title_____

Company & Address_____

_____

1613

GRAPHIC SCIENCE

THE MAGAZINE FOR DRAFTSMEN

OCTOBER 1959

VOLUME I NUMBER I

ARTICLES

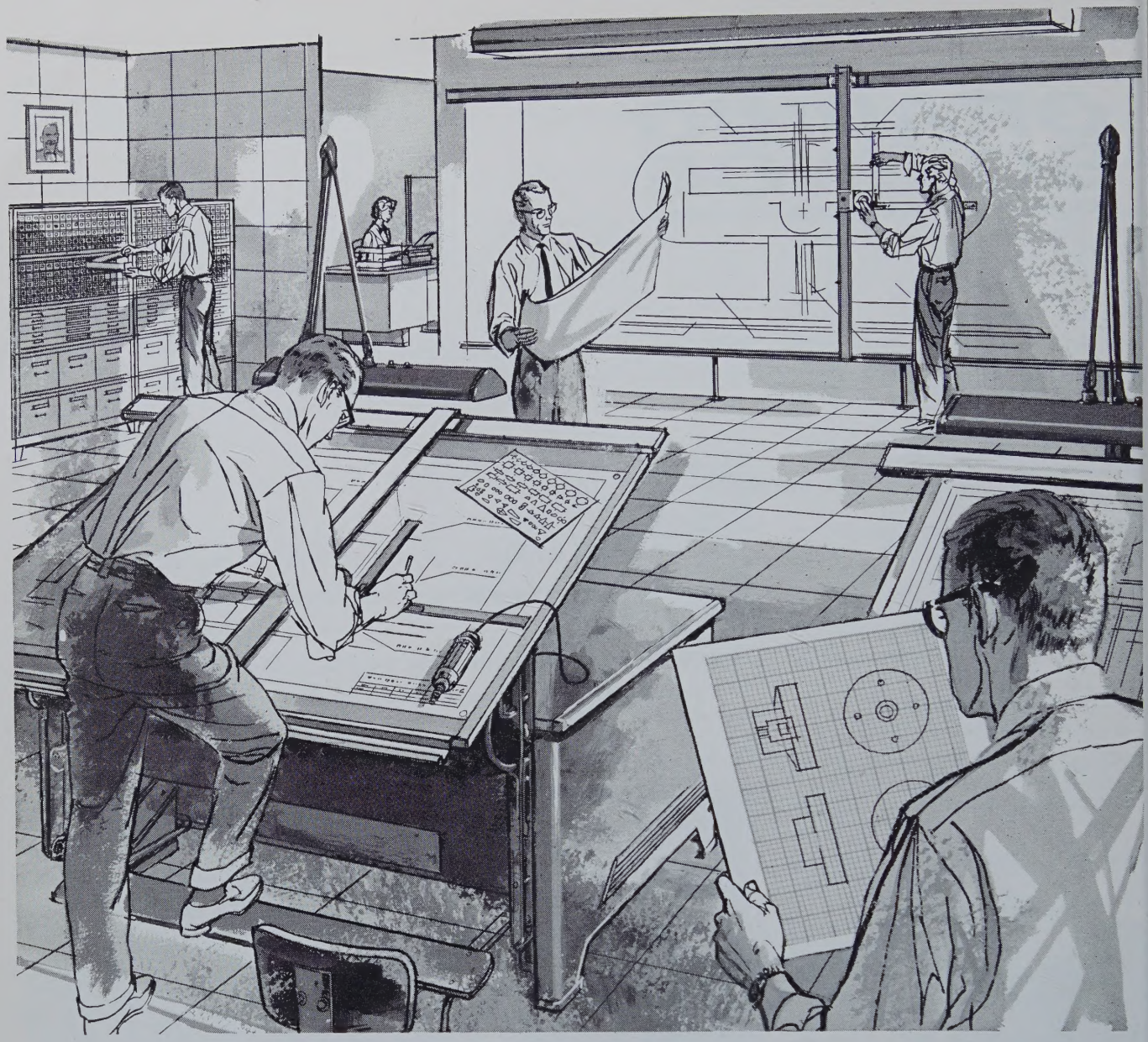
DEPARTMENTS

RAPHIC SCIENCE—offering complete coverage of drafting, technical
ıstration and reproduction for chief draftsmen, supervisors and instructors.

APHIC SCIENCE is published monthly by elow Publishing Company, Inc., 103 Park enue, New York 17, N. Y. (MUrray Hill 5-1745). arles E. Rhine, president; C. Paul Yake, vice sident; David Z. Orlow, secretary-treasurer. APHIC SCIENCE is published (printed) at 116 Main St., Norwalk, Conn. Address changes, undeliverable copies, and orders for subscriptions should be sent to 103 Park Avenue, New York 17, N. Y. Postmaster: Form 3579 requested.

Subscription rates: $8.00 per year in the United States; $9.00 per year to Canada; $10.00 per year to other countries. Single copies: $1.00.

Application for acceptance as controlled circulation publication pending at Norwalk, Conn. The name "GRAPHIC SCIENCE" is Registered, U.S. Patent Office.



new ideas in drafting

Today's engineering and production achievements are miracles of teamwork. The teamwork of scores, hundreds and even thousands of specialists whose talents are coordinated through rapid and accurate interchange of ideas. Modern drafting, printmaking techniques and equipment have made this possible.

The primary communication media throughout industry are the technical drawings. Representing a sizeable expenditure of engineering and drafting time, often each become worth thousands of dollars. It is a fact that approximately seventy per cent of total engineering costs are in the drafting room.

Dietzgen's long experience and continuing research have played an important part in providing improved equipment, materials and methods which have greatly increased the efficiency of the draftsmen. New time saving drafting shortcuts . . . second working drawings by means of subdued reproducible prints, gridded no-print media and new drafting bases that are permanent and dimensionally stable . . . new drafting machines, templates, erasing machines, cleaning compounds and modernized drafting furniture speed his work.

No organization can afford to ignore the advantages and economies possible in modernized drafting and reproduction. But there is no ready-made solution to all problems. Requirements vary broadly even in similar companies and the proper techniques, materials and equipment must be selected carefully from the wide array available. Dietzgen experience can save you time and trouble; let us study *your* problem. We do this regularly for many companies. Write or phone us today. Dept. 21

EUGENE DIETZGEN CO.

PRINCIPAL OFFICES:
Chicago • New York • New Orleans
San Francisco • Los Angeles • Calgary

SALES OFFICES AND DEALERS IN ALL PRINCIPAL CITIES

DIETZGEN

EVERYTHING FOR DRAFTING SURVEYING & PRINTMAKING

PRECISION EQUIPMENT & SUPPLIES FOR ENGINEERS, ARCHITECTS, DRAFTSMEN, SURVEYORS AND SCIENTISTS

DRAFTSMEN—*Where to from here?*

by Irwin Wladaver, Associate Editor

Every vocational and professional group stops at one time or another in its development and takes a critical look at itself. If it likes what it finds, that is, if it has achieved some degree of public acceptance in the form of status, it begins to regroup and to establish rules that will accept or exclude newcomers on the basis of stipulated qualifications, educational or other.

At the present time a reassessment is taking place in engineering education, following a tremendous expansion of knowledge in the physical sciences. I think it will have a profound effect eventually on draftsmen and their status in society.

Not very many years ago, a man could proclaim himself an engineer and there was no one to deny him or to question him. An experienced draftsman could decide to go into business for himself, set up an office—in his hat, if he had one—and succeed or fail in accordance with his ability and his luck.

Today it's different. Without a degree from a recognized engineering college, it is nearly impossible to enter engineering practice at any level at all. While I'm acquainted with a number of fine engineers who did it the hard way, the number of such valuable people without formal engineering schooling or degrees is diminishing each year.

Tomorrow it will be different in still another way. If today's curriculum makers are right, if the changes they propose to make in engineering education are adopted, then the engineer of the future is going to be a different breed from what we have been turning out. The "skill" courses like machine shop, engineering drawing, and other "laboratory" courses perhaps including machine design, will be largely unknown to the new "scientific" engineer.

The move toward more science in engineering is inevitable and welcome. Wherever the certainty of science can replace empiricism, wherever certain knowledge can replace even long-accepted conclusions based solely on experience, it must be freely granted that this is engineering progress and all to the good. Our industrial society will surely stand to gain. But industry will not be the only beneficiary.

The Pivotal Point

Draftsmen are going to profit from the coming scientific curriculum in engineering education. It may in fact be a pivotal event in the improving status of draftsmen.

Unless I miss my guess, within the next five or ten years the new crop of scientific engineers won't be able to read a drawing, much less make one. They may grudgingly try to make a sketch or two, but their sketches will be crude at best and utterly unintelligible at worst. It will be the well-trained, thoughtful, sometimes stubborn but competent draftsmen who will save the engineers from their design failures—it happens even now, they tell me. It may be true that the new engineers will be good theorists. Four or five out of a hundred may prove to have real stuff. But the common everyday variety of new engineer will be lame without the crutch of a good draftsman to support him and to interpret for him.

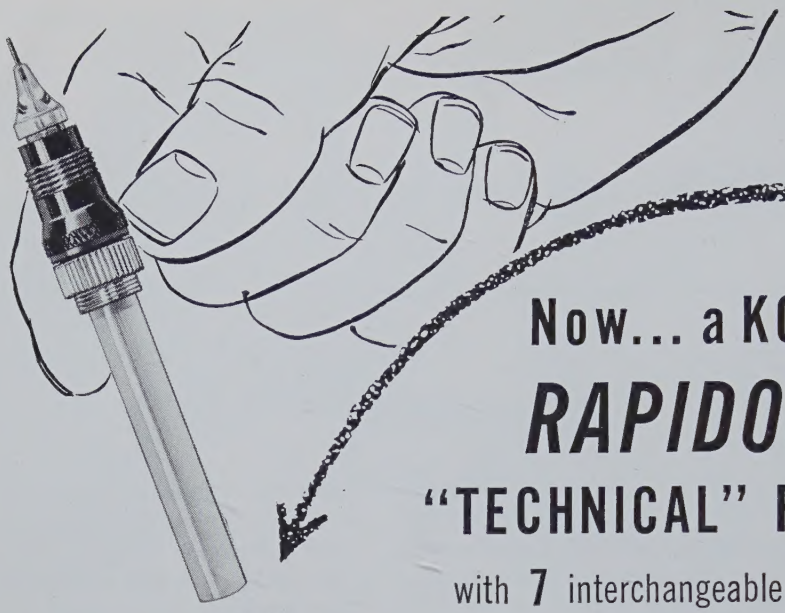
This is a wonderful opportunity for draftsmen to move ahead in the world of engineering and industry. I believe that more and more the call will come for draftsmen to take the initiative and the responsibility for many elements of engineering design, far above what they are already doing now.

It may be that the advent of the new scientific engineer will be the impetus to an expanding field for draftsmen. It may be just the shot in the arm that will make draftsmen sit up and notice that a great new opportunity is opening up for them. There will be important responsibilities to be grasped, together with the rewards and the recognition that come to those who are ready.

The Author

Irwin Wladaver, Associate Professor of Engineering Drawing, New York University, is former editor of the ASEE Engineering Graphics Division's publication, *The Journal of Engineering Drawing.*

Courtesy of Chance Vought Aircraft, Inc.



Now... a KOH-I-NOOR *RAPIDOGRAPH* "TECHNICAL" FOUNTAIN PEN

with **7** interchangeable drawing point widths.

Each individual drawing point section complete with airtight refillable ink cartridge.

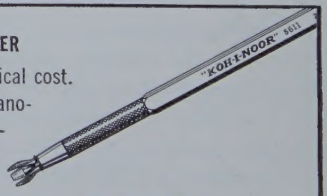
MODEL No. 3065: This new model, like the standard Rapidograph, is non-clogging when used with either India or regular writing ink for ruling, lettering, tracing or writing. Designed to meet the special needs of the professional who requires frequent change of the seven available "Color-Coded" line widths in desk and board work. The interchange of point sections is accomplished quickly, and with complete cleanliness. The set box serves as a handy permanent container for the holder and set of 7 point sections.

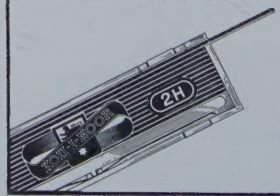
RAPIDOGRAPH Non clogging "TECHNICAL" FOUNTAIN PEN

MODEL NO. 3060: The regular Koh-I-Noor Rapidograph "Technical" Fountain Pen, with pocket clip, is a standard drafting room tool. Self-contained automatic filling system. Made in the same 7 precision line widths.

No. 5611 KOH-I-NOOR LEAD HOLDER

High quality, all metal, at economical cost. Attractive lightweight red barrel, anodized grey knurled finger grip; non-slip clutch holds 10 degrees of lead (2B through 6H).





No. 2200-I KOH-I-NOOR EJECTOMATIC LEAD DISPENSER

A flip of the thumb feeds lead to Lead Holder cleanly, without need to touch the lead. Available in 17 degrees of hardness.

Write for Catalog.

KOH-I-NOOR PENCIL Co., Inc. BLOOMSBURY 16, NEW JERSEY

Scribing

A comprehensive report of the current techniques being used in the electronics, mapmaking and aircraft industries, and an evaluation of the potentials it offers for more general drafting use

by Charles H. Stein and John J. Cramer

SCRIBING, a technique used by prehistoric man to produce rock engravings some 100,000 or more years ago, is coming into widespread use in modern drafting rooms. Present-day scribing was developed in the mapping field, adapted to the aircraft industry and is gradually being incorporated into ordinary drafting.

Why? Scribing offers exceptional accuracy, speed and esthetic appeal. It gives a clean, sharp line and reproduces with unusual fidelity. For the average draftsman, inking is a tense, nerve-wracking ordeal filled with hazards—and a task to be avoided whenever possible. Scribing simplifies the mechanical aspects of the draftsman's job.

Scribing is incising into a surface; it results in what we term a "negative" image. Drawing, by contrast, deposits a line image on the surface; this we call a "positive" image. While it is usual to refer to an image having white or light-colored lines on a dark surface as a "negative," this terminology is also used to describe an image below the surface (incised). Instruments used for scribing are similar to those used for conventional drafting, except that scribing points are used in place of drawing pens or pencils.

Some History

SCRIBING (or engraving) has been practiced on various surfaces and materials. Woodcuts, copper engravings, even lithography (engraving on stone) are all techniques developed from the original principle of scribing into a surface rather than drawing on it. Reproduction of scribed masters was usually by printing means, applying ink to the image and pressing it to the desired medium.

An opaque, paint-coated glass sheet was the first type of scribe-master that could be reproduced using a photosensitized sheet. Light passed through the image lines where the opaque coating had been removed and was held back by the unremoved coating. Another development was the introduction of wet-plate glass negatives. Here the addition of finely scribed lines to a glass photographic negative enabled lithographers to add fine detail to their plates.

A major problem with the glass scribing base was its brittle, inflexible nature. It was hard to handle, work on and store. What was needed for this purpose was a flexible, tough, transparent material that could be coated with an opaque substance easily removable with a scribing tool. Sheet vinyl chloride acetate was the first film hard enough to prevent a scribing tool from cutting into its surface. However, vinyl is made with a plasticizer to give it flexibility. The plasticizer gradually migrates to the surface and evaporates, leaving the vinyl in a very brittle state. A sudden jar, such as that sustained by a sheet falling to the floor, is sufficient to shatter vinyl. In addition, vinyl did not have the necessary dimensional stability to afford the close registration needed.

A film product which has already gone far to revolutionize the uses of the scribing technique is a polyester-base material (polyethylene tetrephthalate). It possesses both the necessary toughness and dimensional stability. A method of coating this new film base with a specially designed scribable layer has also been developed. The resultant scribe-coated film,[1] together with improved scribing tools and excellent photographic techniques may be credited with the rapidly increasing use of scribing today.

[1]The film, called Stabilene, is a trade-name product of Keuffel & Esser Co., Hoboken, N. J. The base of Stabilene film is Du Pont's Mylar, restabilized by K & E.

Base Material

ANY discussion of negative scribing should begin with a review of the required properties of the base material. Its function is to support the coating so that accurate scribing and reproduction detail is readily achieved. The base material must be optically and actinically transparent, allowing the passage of light through scribed lines for photomechanical and photographic reproduction. It must have a smooth surface, sufficiently hard to resist penetration by scribing tools under normal pressure. It must also possess a high degree of dimensional stability to variations in temperature and humidity. The material should be light and flexible, yet sufficiently tough and durable to withstand handling, storage and shipping. Once the scribing point has penetrated the coating and is in contact with the base material, it should glide easily over the surface under normal pressure without digging in. Whether or not it will do this is dependent on the surface finish and hardness of the base material (assuming the scribing point to be correctly ground).

No material is ideal in all respects. For example, while the superiority of glass as to surface finish, hardness and stability is unquestioned, the obvious

Courtesy of E. I. Du Pont de Nemours & Co., Inc.

PENCIL originals on drafting film are transferred to scribe-coated polyester film by draftsmen at Kaman Aircraft Corporation as part of the lofting operation.

objection to its use is its susceptibility to breakage. Vinyl film is better than glass as far as breakage is concerned. However, the polyester-base film[1] is far superior to both in shatter-resistance and general strength. The polyester-base film also compares favorably with glass as to stability; the average thermal and hygroscopic stability of this remarkable film is 0.000006 in. per in. As compared with glass, the plastics films require a slightly greater sensitivity of touch on the operator's part. This appears to be easily acquired and in addition, spring-loaded tools are now available which apply the exact amount of pressure needed to scribe perfect lines. The polyester-base film possesses the required transparency, it has high tensile and tear strength, it is flexible and it is unaffected by most chemical reagents and solvents.

Vinyl chloride acetate sheet is produced in thicknesses ranging from 0.005-inch to 0.125-inch, in increments of 0.005 inches. The 0.010- and 0.015-inch thicknesses are those most extensively used as a scribing base. Both direct and reversed contact photoprinting is possible with minimum line distortion when the thinner, polyester-base film[1] (0.003, 0.005 and 0.0075 inches) is used. Its thickness is a distinct advantage in any operation where two or more sheets are superimposed to verify the registry of detail.

Scribe Coatings

The most critical single requirement for successful scribing is a good coating. From the very beginning this has been a problem and much research effort has been expended in the attempt to develop a coating which satisfied the following requirements. (1) It must be sufficiently transparent to allow copy placed under it to be observed and traced. (2) It must be sufficiently translucent to allow guide copy, printed on the surface, to be similarly followed when lighted from beneath. (3) It must be opaque to those wavelengths or lights which affect photosensitive emulsion. (4) It must adhere tightly to the base material so as to permit the scribing of fine and intricate detail, yet be easily and cleanly removable with properly sharpened scriber points. (5) It must be sufficiently non-abrasive to cause minimum wear on the scribing point. (6) It must be soft enough to permit easy movement of the tool and yet hard enough to resist accidental mutilation during the necessary production handling. (7) It should be receptive to water-base sensitizers,[2, 3] yet suitable for photomechanical etching with solvents that are safe to use in confined areas. (8) For some uses it should also have a good drafting surface for pencil.

It is apparent from the above requirements, that the production of good scribe coatings has been no easy task. Early coating of glass plates was done in the photographic laboratories by the whirling method, using a commercially available pigmented solution.[4] This same coating was later applied to the plastics film and is still being used. Although a few Government agencies still prefer to coat their own sheets, the trend is toward the use of precoated products now on the market.

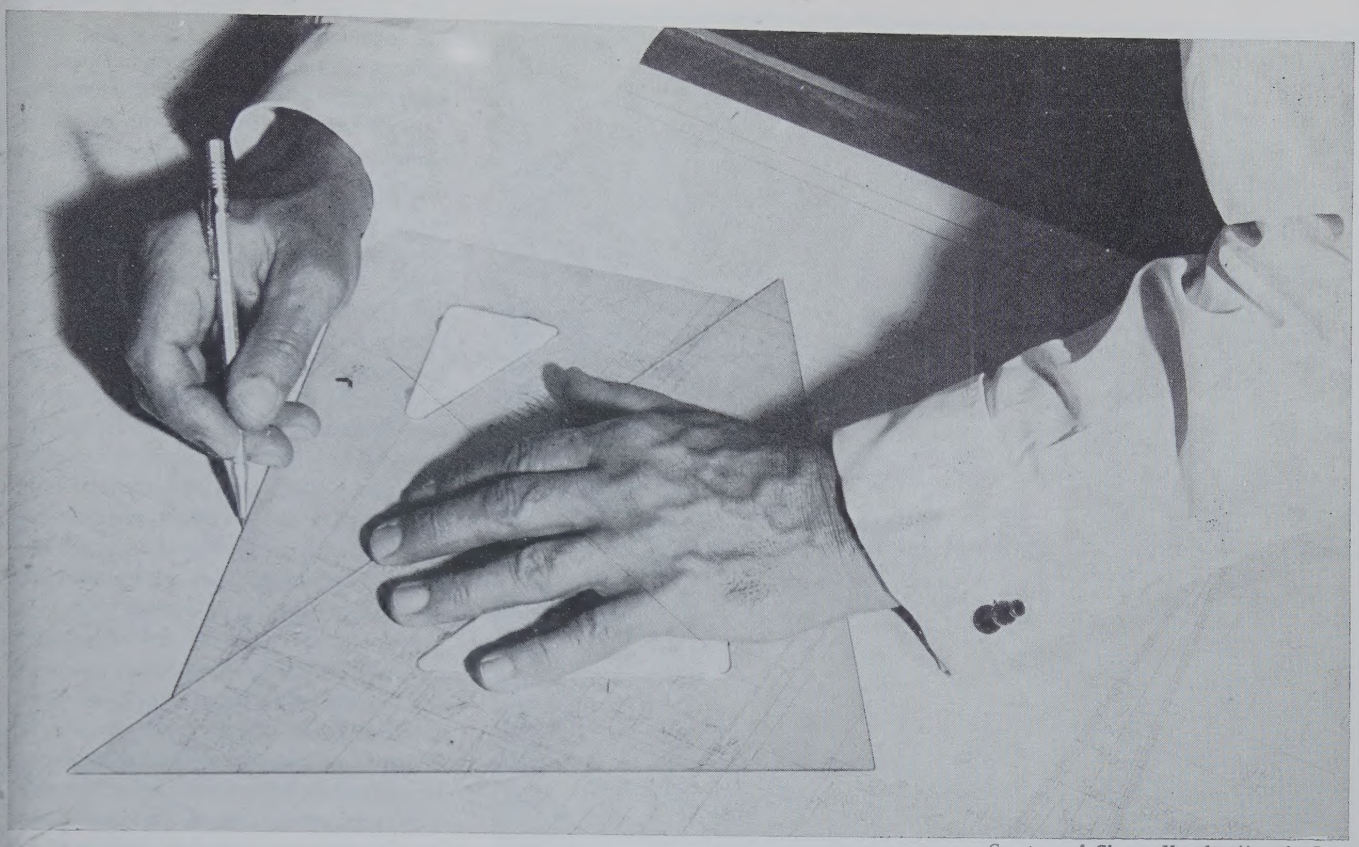
Research in coating materials and methods is continuing. Recent developments indicate that dyed coatings may eventually supplant pigmented coatings, because they are more transparent, less abrasive and equally satisfactory in most other respects. Newly developed orange-tinged coatings, which seem very promising, permit the photoprinting of either film positives or press plates yet have sufficient visual transparency to allow the tracing of detail without the use of a light table. The colors of some coated sheets can also be modified by immersion in dye solutions, either before or after scribing. Two disadvantages encountered in some dyed coatings are the lack of visual contrast between the coating and scribed detail and the fact that coating residue left in the lines is difficult to detect.

Instruments

The instruments used for scribing are the same as for conventional drafting except that scribing points are used in place of drawing pens or pencils.

One type of scribe point commonly used is made of carboloy, ground to a cone point (like a pencil point) and then ground flat on the tip to produce a desired width of line. This type point is held in a conventional leadholder (since it is of approximately the same thickness as drawing pencil lead). Another type point is used in an angle holder. The point is held perpendicular to the work while the handle rests in the hand in the con-

[2]Watercote;
[3]Colorline;
[4]Flo-Paque



Courtesy of Chance Vought Aircraft, Inc.

CARBIDE STEEL SCRIBER, held like a pencil, produces clean, sharp lines and letters on scribe-coated polyester film.

ventional pencil grip. This point is also carboloy and may be obtained in point sizes graduated to scribe various width lines. For circles, a carboloy scribe point is inserted in a conventional compass in place of the lead and used in the standard manner.

When a design has been penciled in, the outlines are then traced using one of the scribing points described. Free-hand lettering is also done with a standard scribe point.

Present-day map scribers are, in some instances, modifications of instruments originally designed for engraving on glass. These instruments are designed to hold the scribing points at certain angles to the surface. Although there is considerable variation in details, typical instruments in use may be divided into five general categories.

1. The crow-foot scriber. This instrument has three ball-bearing feet and the scribing point is held in a fixed vertical position. The latter consists of a round needle with a flat-tipped conical point held vertically so that a line of the same width is cut, no matter in what direction the graver is moved. The scribing point is spring-loaded so that pressure of the point against the scribe-coat surface is automatically correct. The crow-foot scriber may be used freehand or in conjunction with straightedges, templates or other guides. Conical points wider than 0.015 inches are difficult to use because they do not penetrate the coating readily, but "chisel" or "spade" points used with swivel scriber allow lines up to 0.06 inches in width to be scribed easily.

2. The swivel scriber. This is a variation of the rigid graver, but the carriage has different shape and is weighted. The scribing point is held in a ball-bearing, freely turning arm which swivels to follow any direction in which the carriage is moved, so that the scribing edge remains always at the same angle to the direction of the line being scribed. The swivel graver is used to cut parallel lines, analogous to lines drawn by the conventional double-line swivel drafting pen, or very wide single lines. For scribing double lines, a double scribe point in various widths is used, and even triple point for triple lines may be obtained. This graver also features spring-loaded points for good control of applied pressure.

3. The pen-type scriber. This graver consists of a needle in a pen-staff style of holder and is intended primarily for freehand scribing, although it may also be used in conjunction with a template or other guide. Because the point is not fixed at a constant angle to the surface, it is provided with a round point so as to operate uniformly at a variety of angles without scratching the base material.

4. The building graver. This is a specialized instrument used to scribe the solid rectangles or squares which traditionally symbolize buildings, hence its name. The body of the graver rests directly upon the scribing surface. From it protrudes an arm on the end of which the wedge-type scribing point is fastened. The arm is held by springs in a raised position. The width of the cut is governed by the size of the blade used and the length by a setscrew which adjusts the horizontal stroke. Scribing is accomplished by pressing downward until the point penetrates the scribe coating, then pulling backward until the full length of cut has been made. Upon release of pressure, the arm automatically returns to its original position. Variations in design exist and building gravers are sometimes mounted in special bases to facilitate building alignment and spacing and

Courtesy of E. I. Du Pont de Nemours & Co., Inc.

MAPMAKING operations at C. S. Hammond & Co., using scribe-coated polyester film.

to permit the scribing of dashed lines.

5. The dot graver. This instrument, either manually or electrically operated, consists of a structure containing a vertical shaft, on the lower end of which is a chuck to hold the scribing point. The manually operated dotter has a shaft assembly similar in principle to a push drill; a downward stroke causes the shaft and point to rotate. The rotating point of the electric dotter is brought into contact with the work surface by pressing a finger button. Both instruments have built-in springs which lift the point from the work surface when finger pressure is released. For dots up to 0.008 inches in diameter, a flat-tipped triangular point gives satisfactory results. For larger dots, a 90-degree, wedge-shaped blade is more effective.

Scribing points are of two principle shapes: the blade-type with a wedge or chisel-shaped edge and the round, needle-type with a cone-shaped tip having a flat-ground point. A variation of the latter is a round-tipped needle used with pen-type holders and normally confined to the scribing of very fine lines. Scribing points must be carefully ground to the required line widths and the most effective cutting angles. Most users prefer the permanent carbide-tipped points, normally pre-sharpened by the manufacturer.

Uses in Mapping

Since present-day scribing was developed in the mapping field, we shall first examine the uses and techniques applied there. In the cartographic industry, scribing has been found superior to pen and ink drafting and other traditional methods in the following principle respects.

First, it requires a shorter initial training program for new employees. Because scribing is done with precisely ground scribing points held in fixed relationship to the work surface, the need for sensitive control by the operator to produce accurate line widths has been eliminated. The highly developed "draftsman's touch" and the delicate craftsmanship of the copper engraver are no longer required. The trainee's effort can be toward learning to delineate accurately and acquiring the overall map knowledge essential to the cartographic technician.

Second, the production rate of trained employees becomes higher as instruments and techniques are improved. Scribing is more adaptable to mechanization than other methods. For example, templates permit scribing many outline-type symbols formerly printed on adhesive-backed material and applied to the color separation drawings. This contributes to speed and accuracy and also to the permanency of the symbols. In pen and ink drafting it is difficult to keep the background clean and to maintain adequate density of inked lines. Normal handling weakens the contrast below minimum reproduction needs. A greater proportion of time may now be devoted to accurate delineation, rather than to line quality. Production is increased because there is no need to stop for "inking up," pen wiping and ink drying.

Third, despite increased production, the quality of the finished product is surprisingly improved. Line widths are accurately controlled by precisely ground points, whereas pressure on pen points, ink consistency and the texture of drafting surfaces control line width in conventional drafting. In addition, inspection for quality, uniformity and width of line work is facilitated and more attention may be concentrated on accuracy of map content. The nature of scribed lines is such that their precision may be verified with a minimum of review. The quality of negative scribing is retained through the platemaking stage, permitting finer lines which contribute to the neat appearance of published maps.

Fourth, scribed negatives allow the lithographic plates to be processed directly from the scribed work by simple phototransfer procedures. This eliminates camera work and lessens the deterioration of line quality. The negative scribing method permits more flexibility in procedures as the need arises. Prime examples of this are: (1) the introduction of transparent coating to permit the trace

scribing of detail underlying the coated sheet; (2) a method of solvent-etching type and symbols into the scribe coating through a light-hardened pencil emulsion, and (3) the use of coated plastic sheets as compilation bases, after which the compiled detail is scribed directly thereon to form reproduction negatives.

Fifth, scribed negatives lend themselves to revision of base information as is required in most mapping and charting programs. This obviates the need for reverting to inked drawings and reprocessing negative copy to effect changes in map data.

Sixth, the handling of scribed map components is more convenient than handling metal-mounted drafting boards or glass negatives. Storage and shipping problems are minimized because of less volume and weight. Copy is more resistant to damage.

From the forthgoing comparisons, we can see that scribing is one of the greatest advancements in the cartographic field, both military and civilian. Scribed negatives possess unlimited potential for process design to suit the specific requirements of modern cartographic operations.

Guide Image

The accurate and selective scribing required for each color separation in mapmaking is performed as a rule with the aid of a guide image processed on the scribe coating. The exact procedure for obtaining a "manuscript" copy suitable for processing the guide image is dependent on the nature of the original "manuscript." The master compilation is usually photographed to obtain a negative at color separation scale, although the preparation of scribed compilations at reproduction scale is gaining favor. In any case, if the scribed color separations are to be used for direct exposure of the press plates, the processed guide image should be left-reading (mirror image) so that it will be a normal left-reading negative when scribed. The press plates, when processed, will become normal right-reading images suitable for offset printing.

A variety of phototransfer processes may be used for preparing the guide image. One of the simplest, requiring a minimum of equipment, employs a commercial sensitizer[2], available in several colors. The sensitizer is applied to the coated sheet by flowing, swabbing, rubbing or whirling, whichever is most convenient. After it dries, the prepared sheet is placed in contact with the manuscript negative in a vacuum frame and exposed to intense light. The exposed sheet is flushed with ammoniated water, rinsed in clear water and, if required, swabbed lightly with cotton until the image is sufficiently defined; it is then removed from the water and air-dried. The sheet is now ready for scribing.

A sheet is prepared in the above manner for each separation required. These individual guide copies are commonly referred to by the color of the features that are to be reproduced therefrom: i.e., "black copy" or "black guide," " blue copy," etc., or by the class of features such as "culture copy" or "culture guide," and "drainage copy." A selection may be made to reserve the more legible images for the more intricate scribing.

Some maps are made by separating detail, such as planimetry on one sheet and topographic relief on another. Where this method has been employed, or where detail is recorded on a separate sheet to supplement the basic compilation, it may be advantageous to process the guide image in separate colors. The different colors of the composite copy aid the scriber in interpreting the copy. The multi-color image is produced by successive exposure and development, using a different color of sensitizer[2] in processing each component.

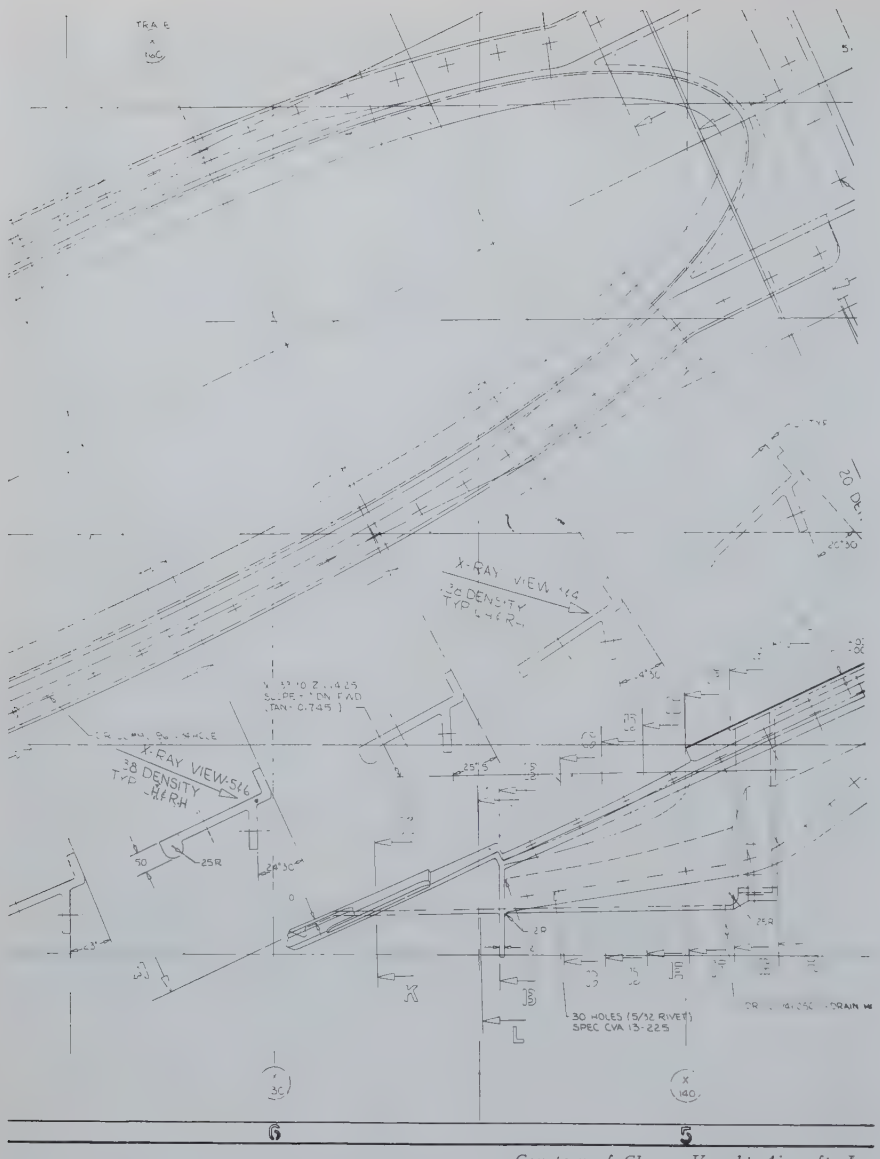
Color Separation Scribing

The objective in color separation scribing is that of producing finished negatives suitable for use in preparing lithographic press plates. To accomplish this, all required imagery must be scribed cleanly so as to completely remove the coating and leave the base material unmarred. The work is usually done on an underlighted table with sufficient room illumination to allow easy reading of the image and proper operation of the gravers. The use of a blue filter is helpful in determining whether or not the line work is absolutely clear.

Scribing techniques will vary slightly with individual operators but in general gravers are designed and sharpened to do a specific job and will be used in like manner by different operators. Corrections may be made by painting out the incorrect areas or lines with an opaquing fluid and scribing the corrections after the fluid has thoroughly dried. The instruments and techniques used in scribing the various categories of map detail are as follows.

Lines 0.006-inch or less in width are usually scribed with the pen-type graver. This graver may be used for freehand work or in conjunction with a straightedge, curve, or any specially designed template. The rigid or swivel scriber may also be employed in any of the above applications at the option of the operator. Line widths up to 0.015-inch may be scribed with the rigid scriber using the normal conical point. This scriber may also be used freehand or in conjunction with a straightedge, curve, or template. If line widths greater than 0.015-inch are desired, a chisel-shaped point will operate more easily. Double lines, such as road symbols, are scribed using the swivel graver fitted with a double-line scribing point. Dashed lines are usually scribed as continuous lines, then broken by opaquing. Dots or dotted lines are best made with the dot graver, equipped with a rotating point. For best results it is essential that all scribe points be properly sharpened in order to assure a clean, smooth line suitable for making high quality press plates.

Map and chart symbols are scribed with the aid of templates, using either the pen-type or rigid graver. Satisfactory templates have been made from plastics or thin metal. Where a variety of standard symbols are involved it has been found practical to have templates produced in quantity by precise punch and die methods. Some of the more complex symbols are not readily adaptable to template scribing and therefore other means must be resorted to in order to properly portray the symbols. For example, (1) symbols and letters in positive stickup form may be affixed to a transparent overlay properly positioned with respect to the map image. A negative of this overlay is made for processing the appropriate printing plate, or the overlay may be processed directly to the scribed coated sheet by photomechanical etching. (2) The scribed negative may be used to obtain a contact positive for the application of additional



Courtesy of Chance Vought Aircraft, Inc.

TYPICAL drawing on scribe coat; note that grid lines are five inches apart on original.

symbols and lettering. A negative must be prepared from this positive for processing to the appropriate press plate. (3) Stripping film with a negative image of symbols or letters may be applied directly to the scribed sheet after removing the scribe coating in the area where the symbols and letters are to be inserted.

The portrayal of area features, such as woodlands, swamps and bodies of water, requires that the area be prepared in such a manner that solid tints or appropriate patterns may be printed. The relative extent of the area involved determines whether they are prepared in positive or negative form.

Areas to be printed in solid tint are usually prepared by one of the following methods: *a.* by removing the scribe coating from the plastics base by first scribing the outlines, then scraping the coating from within the scribed lines, or by painting the areas with a waterbase, solvent-resistant material and washing away the unprotected portions with solvent; *b.* by opaquing the selected areas on a transparent overlay; *c.* by peeling a special film from its plastics base after the area outlines have been scribed, cut or etched.

Areas requiring patterns may be prepared as for solid tints. If only one type of pattern is to be shown, the open areas may be processed to the press plate through an interposing screen containing the pattern. If several patterns are to appear simultaneously, they may be stripped on the appropriate areas. If suitable scribe coatings are used, patterns may also be photomechanically processed and etched. In certain instances, for practical reasons, the patterns are sometimes scribed manually.

Aircraft Template Uses

Previous to the development of a stable base film for accurate template layout work, the master drawing was made directly on the metal. This entailed original dimensional layout work on paper or cloth and then transferral to the metal by re-drawing to scale. Many problems and additional errors were encountered because of this extra drafting. In lofting to scale on the metal sheet, there was the difficulty of handling the metal as well as the awkwardness of drawing on the larger size. Duplication of a master meant complete re-drawing.

The introduction of glass cloth as a "to-scale" drafting medium did much to alleviate these difficulties. However, scribing—although introduced relatively early in the industry—did not catch on. Glass cloth was extremely difficult to scribe since the scribing point had a tendency to cut into the base and catch on the glass fibers. The aircraft and automotive industries were forced to depend on pencil and ink drafting until the development of the polyester-base scribe coat film[1]. This specially coated film has made possible full-size master drawings which are completely accurate.

Parts requiring exceptionally close tolerances can now be scribed to scale. All of the engineering and tooling information required for producing the part is on the scribed masters. These masters can be easily transported because they are light in weight and they can be rolled up. Reproductions can be made directly onto the surface of a coated metal template. Using simple photographic procedures, the master (scribed full size—to scale) can be transferred to the template in a matter of minutes. If an error is made in the template stage, it is an easy matter to make a second template from the accurately scribed master, thus saving many laborious hours of re-drawing on a new template.

The master draft is controlled by certain factors of basic engineering design. These control factors include

stress or load requirements, contour and interchangeability with other assemblies. The start of the layout is usually the establishment of a basic contour or mold line. This is plotted from the stations or sections and worked out mathematically. It is done in a conventional manner, but instead of developing the contour on a metal template, a sheet of the scribe-coated film is used. The mold line is developed using a pencil with ordinary graphite lead, plastic lead or a metal lead (such as silver or gold). The scribe-coated film in this case is a buff or white color, having a dark green undercoat. Excellent contrast is possible between the penciled lines and the scribe-coated surface. After establishment of the master lines at the proper stations (in pencil) they are scribed into the coated film surface. As a rule, a standard carboloy scribe point held in a lead holder is employed for the scribing. (The scribe-coated film being used has an interesting property. Since it has a dark green undercoating, a line scribed on the buff or white topcoat will allow the dark undercoat to show through.) The fully scribed line penerates the coating—both top and undercoat— down to the base film. The cut edge of the undercoat makes a vivid contrast with the light buff or white surface, making it very easy to see where a line has been scribed.

This master coutour or mold line is the basis of the future design stemming from it. These further developments are made by photocopying the original scribe master on the photosensitive scribe coat. This is traced by scribing and additional details are added on this secondary work sheet. On this sheet the location of all holes and the location and development of attaching parts are included. Note that fits and clearances can be easily checked; hole sizes and the parts in which they are to appear are plainly indicated. Various symbols may be used to indicate coordinating holes. With the completion of the master draft or layout, all information necessary to complete the part will be found thereon. Because of the very great quantity of detail parts involved in aircraft structures, as well as close tolerance requirements and short schedules, the above system of control reduces delays due to errors, repetitious layout and misalignment of parts and assemblies.

Courtesy of Chance Vought Aircraft, Inc.

GRIDS, borders and zones are scribed on grid table; note stored drawings at rear.

When the master draft or layout is completed, one or a combination of the following programs may be established—(1) a prototype program, (2) prototype and production programs simultaneously, or (3) production program alone.

On prototype programs, the essential items are cost, minimum time allowance to a completed product, flexibility of design change and evaluation of the product prior to actual production. The master scribed layout on coated film provides a short-cut method, as the master is also the negative used in conjunction with a contact printing method. The prototype materials are sensitized with sensitive emulsion; this results in a diazo, brown or blue print, or a photographic image. A light source and printing frame must be provided along with the necessary developing solutions. The materials to be sensitized must be clean and free of all oil, dirt and oxide. The emulson is applied by spraying or rolling on the template material. The time cycle required to complete the photowork is relatively short. At this point, the prototype material is ready for final fabrication operations such as trimming, drilling or other standard machine operation. A mirror image (reversed or left-reading) may be made to check the fabrication operations if desired. The part material is placed on the check material with the two photo images in contact; this is commonly known as "shown" and "opposite." The "opposite" image is obtained by merely turning the scribed film master over

at the time of photo-reproduction.

Tool materials for prototype tooling are handled in the same manner. The form tool material (after the photo image has been developed) is cut to shape on a metal cutting band saw, smooth-finished on an abrasive wheel grinder or vertical belt grinder and then fitted to the "opposite" photo image to check contour or shape.

The production program may start simultaneously with the prototype program. In this way, little delay should be experienced between prototype and production programs. Also, interchangeability between the prototype and production tools or parts will be guaranteed. The production program will include long-run tools which in design will incorporate the part simplification and coordination as worked out on the prototype program. As the same master draft or layout used for prototype work may be converted to production, little additional cost will be incurred for the production master draft or layout.

In a production program without prototype or evaluation of test part or assembly, all information on the master draft or layout should be developed for high production. Considerable thought and time should be given to developing and checking the master draft or layout to insure proper coordination of parts, part development, fits and clearances. The successful production program depends to a great extent upon the following factors: (1) the ability of the engineer or designer to see and to eliminate problems of fits and clearances; (2) reduction to a minimum of the necessity for custom - tailoring, or faulty processes on the production line — this is accomplished through proper design and coordination of parts shown on master draft or layout; (3) flexibility, permitting change or improvement; (4) reduction to a minimum of the steps or tools and time required for speedy, hence economical production, and (5) complete accuracy, through dimensional stability of the scribing medium.

Although this system is a development of the aircraft industry, it will lend itself well in most industries where sheet-metal parts are fabricated from single plan layouts. Regardless of the article to be made of metal, the problems of design, forming, shearing and assembly are of the same complex nature.

Uses in Electronics

Another industry beginning to feel the impact of scribing is a relative newcomer itself. That part of the electronics industry specializing in the design of printed circuits or wiring has discovered the many advantages of the scribing system.

Heretofore, printed wiring boards were designed on various media, i.e., Bristol board, tracing cloth and films, and used with either inking or taping techniques. The shortcomings of both techniques are obvious. They include the lack of dimensional stability of the base, inaccuracies in inking due to blots, wide lines, etc., and inaccuracies in taping caused by creeping of the tape. In both techniques, long drawn-out opaquing was required.

In an attempt to overcome these disadvantages, designers turned to scribing for circuit layout work. One method of designing a wiring board by means of scribing, uses several new scribing instruments. Since the circuit runs and lands require that large amounts of the opaque surface be removed, special tools had to be designed. The circuit runs are actually scraped out rather than just outlined. The drawback in this system is the extended time necessary to scribe out the wider lines unless the right tools are available.

Another newer system also requires specialized tools; however, the two tools needed are relatively simple and inexpensive. Also, since the circuit runs are scribed in outline only, less time is required in the high-priced designing stage. The circuit is plotted directly on the scribe-coated film in pencil. A grid, imprinted on the surface, keeps everything in correct alignment. The rough-drawn circuit is then accurately scribed into the surface of the scribe film. Outlining the circuit runs is done with a twin - pointed scriber. The pads are scribed using either a regular compass with a scribing point in place of a pencil lead, or a specially designed tool which scribes both inner center as well as outer circumference of the pad.

When the scribed master is completed (usually at two to four times scale), the expensive designing and layout work is finished. It is taken to a photo-processing section where the master is contact-printed onto a special photo-sensitized film with a peelable coating. After simple photo-processing and etching of the surface (with alcohol) it is possible to strip out the area between the outlines, leaving the circuit run a solid open path and the pads as open discs. The completed double-size master may be contacted to a stable base photographic film to produce a double-size positve, or photographically reduced to obtain a scale-sized positive. If a scale - sized negative is required, it may be contact-printed from the reduced positive.

This method has proven itself to be extremely accurate and requires less time than taping. The accuracy is directly attributable to the extremely sharp, clean lines and close tolerances made possible by scribing. Errors are easily corrected by filling in lines on the scribed master with a crayon-type touch - up or a fluid - type touch - up. Soiling the surfaces of the scribe master will not affect the reprints, since the greater part of the area is opaque.

Scribing Versus Drafting

How does scribng compare with conventional drafting in accuracy, speed, reproduction quality and esthetic appeal? Test results are revealing.

Scribing was compared briefly with pencil drafting. Results showed pencil drawing to be slightly faster, but the accuracy of the work was far inferior to that on the scribed sheet. Lines varied in weight and density. Smudging was noticeable and the sheet in general lacked the trim sharpness shown by the scribed master. In reproduction, there was no comparison. The reprint made from a scribed original was sharp, clear, of excellent quality. The pencil reprint showed fuzzy lines, erased areas and a generally less sharp print.

When inking is used to give maximum reproduction quality, a comparison with scribing easily favors the latter. Tests have been conducted where draftsmen, well experienced in inking procedure, have tried scribing for the first time. Technical imperfections generally present in inking, are eliminated in scribed work. These are, to enumerate a few: (1) variation in line width due to dull, clogged or accidentally maladjusted pens; (2) blots, smears and ink that runs through compass holes in paper to show on the opposite side; (3) smears

due to erasing, where errors have been corrected.

For the average draftsman, inking is a tense, nerve-racking ordeal, filled with hazards—a task to be avoided whenever possible. Here then is the greatest advantage of scribing: all the tested draftsmen agreed that they would much rather scribe than ink.

The comparison tests between inking and scribing were overwhelmingly in favor of scribing insofar as speed was concerned. The time saved over inking ranged from 10 to 50 per cent. One of the members of the test group was a housewife with no drafting experience. With two hours of practice she produced a scribed drawing well able to be used.

More significant than the difference in time is the difference in the quality of the work. The scribed sheets will be found superior to the inked drawings in all cases. Erasures in inking become "fill - ins" or "touch - ups" in scribing. Two correction methods are possible. The quickest and easiest method is used for correcting errors in lines to 0.012-inch in width. This involves use of an orange crayon pencil. Rubbing the point of the crayon pencil over the line (at right angles) deposits an actinically opaque filling in the lines. This will not rub off in normal handling, even when exposed to standard reproduction processing. The second method uses a fluid touch-up. The draftsman paints over the line and allows it to dry, whereupon a new line may be scribed through the corrected area. The crayon pencil "touch-up" may also be rescribed.

In preparing originals on scribe coat, designs are drawn lightly in pencil directly on the scribe surface. Changes and erasures can be made as the design progresses and develops. Overrun lines, poor dash lines, notes hastily written may all be wiped from the surface with a damp cloth after the design has been scribed. In fact, it is not even necessary to remove these errors, since they will not show on a reprint. When a design has been pencilled in, the outlines are then traced, using one of the scribing points described. Reproductions (if positive images are required) are done on blueprint, brownprint or photographic paper, cloth or film. Diazo reproductions made from scribed originals will be negative type prints.

The scribing technique is becoming the modern tool of industry. Whether the field is mapping, lofting, automotive design, aircraft design or circuitry (we have even seen architectural drawings made on polyester-base film) scribing results in lower costs and cleaner, more accurate results. Further, where drafting is an established and fully developed technique, scribing is conducive to further research and innovation. The next decade should reveal spectacular developments in film, coatings, instruments, and techniques.

The Authors

Charles H. Stein and John J. Cramer, co-authors of "Scribing," have both been with Keuffel & Esser Co. since the late 1930's. Both men have been closely connected with the laboratory development of Stabilene film products. At the present time, Mr. Stein is in the Reproduction Department and Mr. Cramer works in the Marketing Planning Division.

A review of procedures found useful at Photocircuits Corporation for making

PRINTED CIRCUIT MASTERS

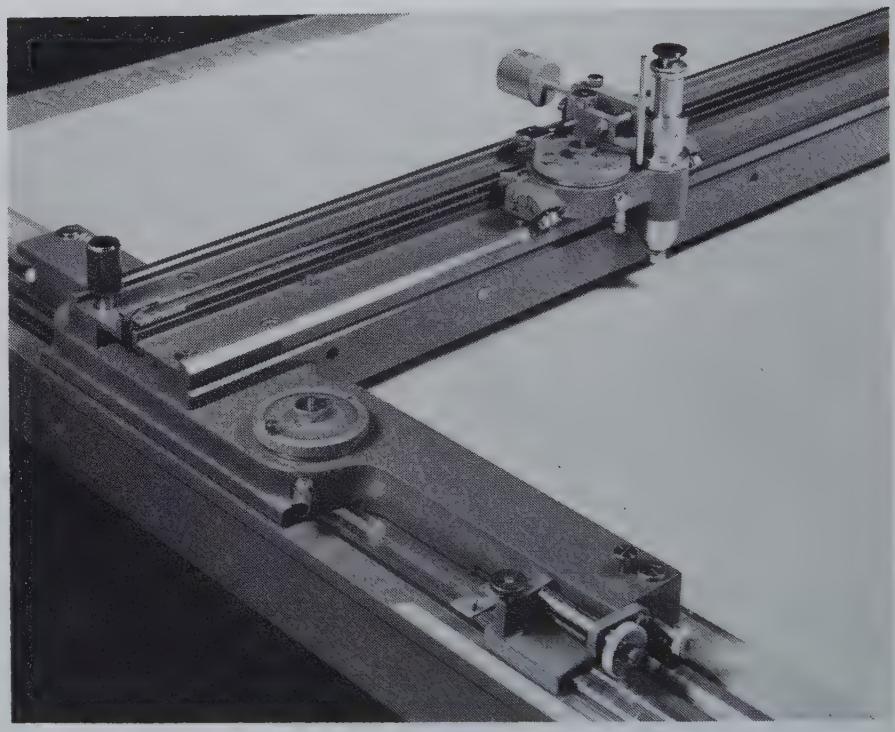
DRAFTSMEN, even those in the electronics field, seem to have a general lack of knowledge of the basic requirements for drawing printed circuit masters. While some draftsmen can draw good circuit masters, many are handicapped by unfamiliarity with printed circuit manufacturing operations which require deviation from normal procedures.

The drafting department at Photocircuits Corporation of Glen Cove, New York, processes more than 20 master circuit drawings a week. Ronny Morino, supervisor of graphic processes, screen making and tooling at Photocircuits, says that a great many master drawings coming through our plant from a customer require touch-up, reworking or complete redrawing. So when a customer is not familiar with the problems of printed circuit layout, we suggest that we make the master drawings ourselves."

Mr. Morino has noticed that along with the increased understanding and usage of printed circuits, masters received from customers have improved in line definition and side to side registration, but he has seen little evidence of a wider knowledge of problems such as conductor plating build-up or screening and etching tolerances which may affect the layout of the circuit master.

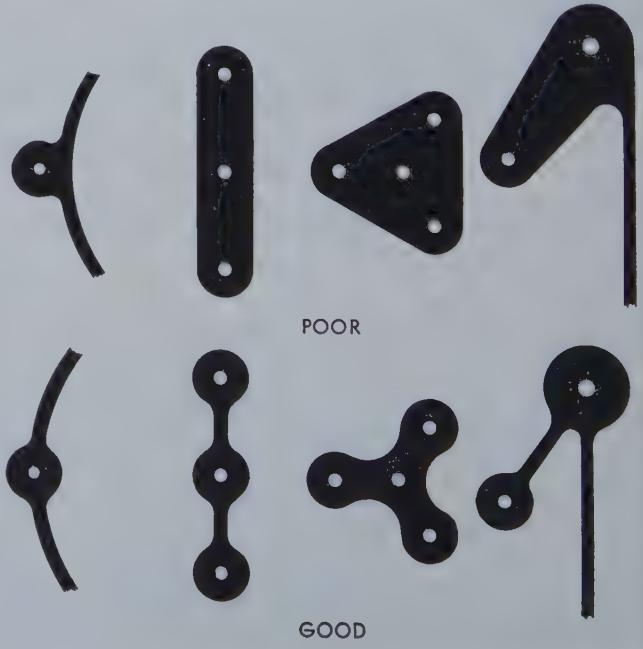
He pointed out that where a drafting department is frequently called upon to produce printed circuit drawings, one or more draftsmen should be appointed to specialize in this aspect. At Photocircuits, they have found that many competent draftsmen in conventional drawing are incapable of the type of precise drawing necessary for printed circuit masters.

A draftsman specializing in printed



CLOSE-UP view of Haag-Streit Coordinatograph (Model A), used in plotting printed circuit masters. This precise instrument is also a checking tool.

DESIGN details to be considered in drawing circuits to be dip-soldered. Land patterns should be symmetrical with holes, since solder tends to flow to the center of large copper areas, providing poor fillets around holes near the edges.



circuits must have, in addition to an extensive knowledge of circuit layout principles and manufacturing processes, the talent of drawing to very close tolerances. The trend toward miniaturization is calling for even smaller circuits, and subsequently, even closer tolerances. In addition, accumulated tolerances can become a very substantial problem in circuit layout.

It should be specified that, since the end product is essentially obtained through a printing process in conjunction with a mechanical fabrication process of conventional nature, the problem of registration often creates the necessity of reducing initial errors to a minimum. A careful study of every possibility of tolerance accumulation should be done before initiating the final master layout. Typical examples of errors deriving from tolerance accumulations are hole to pattern registration, connector finger to edge of board registration, side to side registration, and the like.

Specialization

Although the draftsmen at Photocircuits are trained in all phases of master circuit drawing, there is a tendency toward specialization. One man may make the preliminary sketches, another plot the hole locations, then possibly the front and back circuits are assigned to separate draftsmen for drawing. One man devotes much of his time to checking.

The production of an etched circuit is intimately connected with various photographic processes. Therefore, at Photocircuits the drafting department and the photographic department work right next to each other under the direction of Pat Clohessy, who doubles as chief draftsman and photo department supervisor. His drafting team works solely on circuit layout. His photo department carries the process through to the production of the glass master. The glass master is used by the screen-making department to make a stainless steel screen for printing an acid-resist ink pattern on the copper laminate.

"By supervising both the drafting and photo departments, and knowing the problems and advantages of each," Mr. Clohessy states, "I am able to determine short-cuts for increasing the efficiency of each, yet at the same

CHECK LIST

For printed circuit master drawings

- ☐ 1. Is the drawing made on a polyester based drafting material? Paper and illustration board must be avoided.
- ☐ 2. Is the circuit pattern at least twice size? Preferably, it should be four to eight times final size. However, it should be drawn no larger than can be mounted on the copy board of the camera used in its reduction.
- ☐ 3. Have drilling or spotting guides been designated? An adequate guide is provided by the use of a white dot in the center of the black land pattern such that the final (true) size of the dot will be 0.020″ in diameter.
- ☐ 4. Have 90-degree guide lines been included? These are essential to accurate positioning in the step-and-repeat photo composing machine. Preferably, these guide lines are positioned in the borders of the drawing such that their center locates the exact center line of the master circuit. These lines should be 3- to 5-thousandths of an inch thick at 1:1 scale to assure accuracy in positioning.
- ☐ 5. Has the use of cross-hairs as hole center designations been avoided?
- ☐ 6. Has there been specified just one critical dimension to which the master drawing is to be reduced? This is a photographic necessity. It is best to use the longest dimension on the drawing.
- ☐ 7. Is the smallest line width and/or spacing 0.031″ or greater? It is preferred to have 0.062″.
- ☐ 8. Has the use of etched lettering or numbering been avoided? Legends should be printed in ink instead.
- ☐ 9. Is the land pattern around each hole at least 0.31″ in width? In other words, is the diameter of the copper pad in final size at least 1/6″ larger than the hole size?
- ☐ 10. Are solid copper pattern areas on the side to be dip-soldered broken up by etched areas? To prevent globbing of the dip solder and blistering of the plastic base, there should be no copper area greater than ½″ in both directions.
- ☐ 11. Is the master drawn in ink? Are the edges of the lines clean and sharp?
- ☐ 12. If it is a two-sided circuit, do the front and back master drawings register precisely?
- ☐ 13. Have land patterns been incorporated on both sides of the master where plated thru-holes are specified?
- ☐ 14. Has the master been checked for dimensional accuracy? The largest error should be no greater than one-half the allowable tolerance on the finished part when the master is reduced to final size; i.e., if a land is located within plus or minus 1/64″, the master may have a maximum error of 0.007″ when reduced. If a land is located plus or minus 0.005″, no error on the master should be greater than plus or minus 0.0025″ when reduced.
- ☐ 15. Has an allowance of at least 0.031″ been made between any inked legend and an etched conductor?
- ☐ 16. Have sharp corners on conductor paths been avoided? Have fillets been used to blend conductor paths and lands?
- ☐ 17. Has spacing between conductors or lands on circuits to be plated been increased at least 0.010″ over the required minimum?
- ☐ 18. Is the master drawing being shipped flat? Master drawings should never be rolled or folded.
- ☐ 19. Has a corrected blueprint of the circuit been included with the black and white master drawing?

time can control the quality and accuracy so necessary in a circuit master. When a circuit leaves my department, it goes into production—there is no room for mistakes."

Special Equipment

Chief draftsman Clohessy has little equipment in his department that is not standard in almost any drafting room. As he puts it, "It's the experience and training of our draftsmen that enable us to turn out accurate masters."

However, he does have one machine which he feels is quite necessary to achieve accurate layouts—a Coordinatograph. This is an X,Y plotting machine which can locate any point on a 48″ by 48″ working surface with accuracies up to 0.001″. A printed circuit is a flat pattern, therefore, any point on that pattern can be located by its coordinates. "We're getting away from the limitations of the tenth-inch grid pattern which, when reduced four-to-one, provides a spacing increment of twenty-five thousandths on the finished circuit," Mr. Morino states, "With this new equipment, anything goes." The machine is equipped with a microscope which also permits inspection of the dimensions of a master or negative.

After the circuit layout and hole locations have been determined, the drafting of the master begins on the Coordinatograph. The spotting of the 90-degree guide lines, jig location holes and component mounting holes are made. The X,Y coordinates of each are tabulated, then a microscope incorporating a pricking device is lowered to make a tiny, pricked hole in the drafting material at the precise point of each hole center. The draftsman pencils a circle around each prick and labels it for identification. When two-sided circuits are called for, two sheets of drafting material are placed in the machine and hole locations for both the front and back circuits are made at the same time.

When all hole locations have been determined on the Coordinatograph, the pads are drawn in. These are made by swinging circles around the prick holes then filling in the outline with ink. Pads are always inked rather than taped, because even though

circuit tolerances may not be tight, the pads must be located accurately to permit jig-drilling of the etched circuit boards. Sometimes pencilled circles are made around the pads to determine clearances for conductors.

After all pads are drawn, the hole locations are rechecked. The master is then completed by drawing in the conductors. These are made with tape where close tolerances are not essential; with inked lines where greater accuracies are required.

Final checking of the master drawing includes a close inspection for correct layout, spacing, conductor width, land size, clearance around holes and edges, front-to-back register, line definition, 90-degree register lines, and jig location holes.

Masters

All masters are made on a drafting medium based on polyester film. There are more dimensionally stable materials than polyester film but they are not practical because they are usually rigid and opaque. Small circuits are made on 0.005″-thick film; larger circuits or circuits requiring high accuracy are drawn on 0.0075″-thick film.

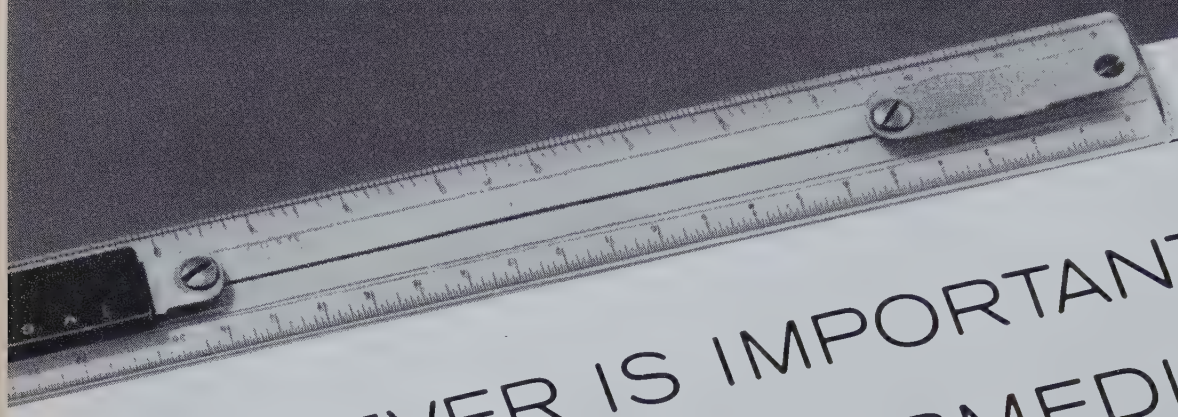
Master drawings are made two to eight times the actual size of the finished circuit, depending on the size of the circuit, tolerances, and line definition required. A circuit drawn to a tolerance of 0.018″ when reduced six times will have tolerances of 0.003″.

Practically all the circuit masters made at Photocircuits are made with an acetate-based ink. This ink has good adhesion and high opacity to assure that there is no light transmission during the photographic steps. The ink also has a dull surface which prevents light reflection during photographing. Ordinary India ink has been found unsatisfactory for printed circuit masters.

"We're continually experimenting with new layout methods," says Mr. Clohessy, "to determine the advantages and limitations of each. For instance, when you make a layout with tapes, care must be taken not to stretch the tape on bends or it will creep, not only making the circuit inaccurate, but the adhesive smear will

(*Continued on page 22*)

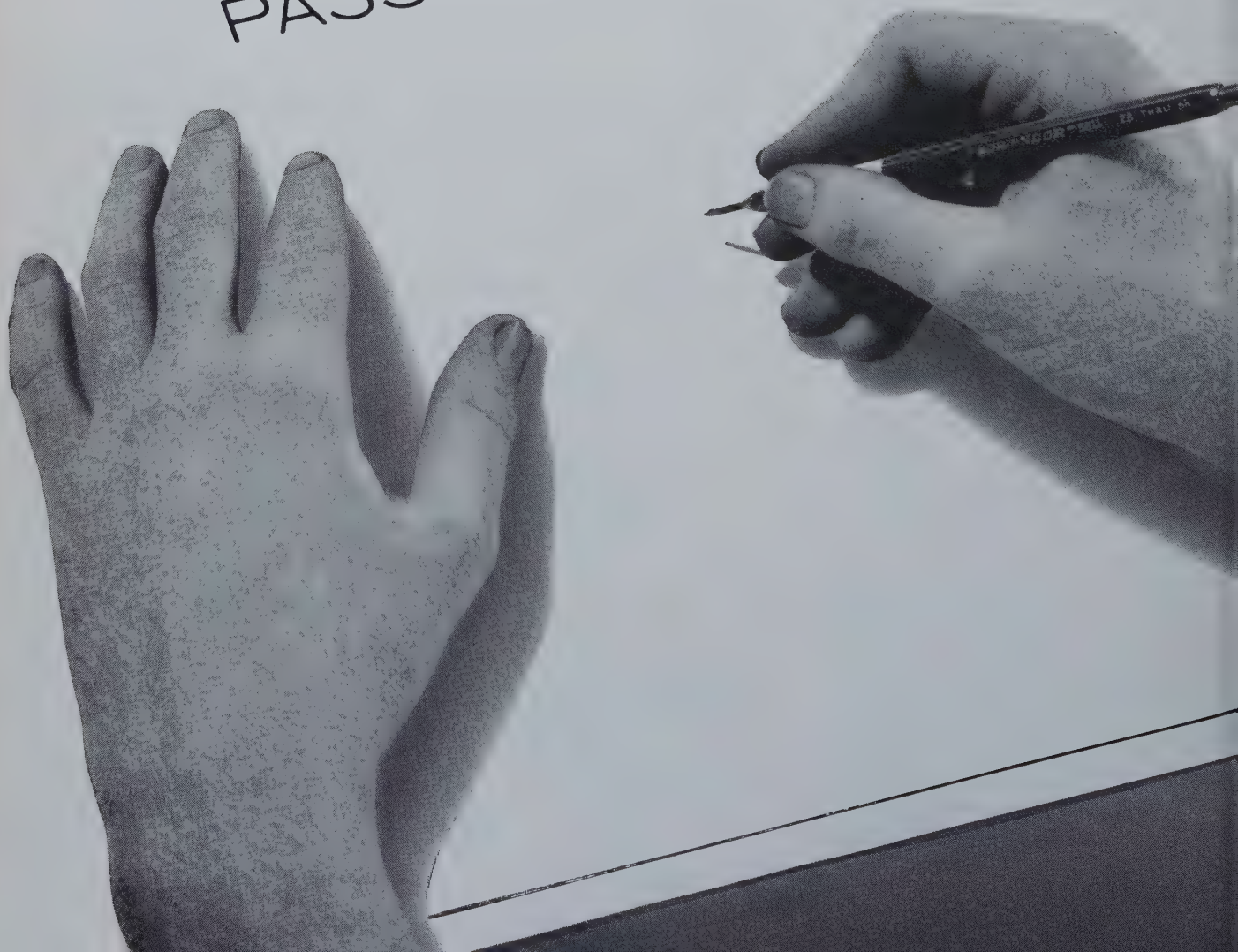
NEWLY IMPROVED



WHATEVER IS IMPORTANT TO YOU IN AN INTERMEDIATE

IMPROVED VAPO-VEL

PASSES EVERY TEST!



POST VAPO-VEL

Here's a sepia intermediate that handles just like the best vellums

As a result of The Frederick Post Company's long and intensive research in intermediates and coating technology, there is now available a dramatically improved sepiatone vellum. POST Vapo-Vel (209) combines *every* important feature you've been looking for in a transparentized paper-base print—top drafting qualities, superior shelf-life and filing characteristics, and outstanding printback speed. An extra dividend: Vapo-Vel's cost per print is surprisingly economical compared to other types of intermediates.

To the man on the board, this newly improved Vapo-Vel is a real find. It has all the drawing and transparency features of a top-notch vellum, even that crisp vellum "feel." Vapo-Vel's easy-to-read dark brown image and outstanding transparency eliminate eyestrain in modification work on the back of reverse-reading prints. The surface takes pencil and ink without feathering. Pencil erasing characteristics of this strong 100% rag premium paper are truly outstanding, while eradication of print images is easily accomplished.

You check it! Whatever your special interest, test 209 Vapo-Vel ammonia process prints for factors most important in your own operations. Whatever your prime requirements may be, POST welcomes a comparative evaluation of diazo-type sepia papers for each and every one of these prime characteristics:

PASSES EVERY TEST!

Image Density—Visual
Drafting Qualities
Line Contrast
Readability thru Back
Eradication
Filing Characteristics
Image Density—Actinic Opacity (Printback)
Quality of Reprint
Image Bleed on Aging
Background Stability
Shelf-Life

Write today for your copy of the POST Vapo-Vel Kit. It contains sample prints to examine and test, a Print Characteristics Checklist, a Data Sheet and a copy of POST's popular booklet "11 Ways to Save Drafting Time." To keep up-to-date with the latest, just write Frederick Post Company, 3668 North Avondale Avenue, Chicago 18, Illinois.

FREDERICK POST COMPANY

CHICAGO 90 • ENGLEWOOD, N.J. • PITTSBURGH • DETROIT • MILWAUKEE • HOUSTON • SAN FRANCISCO • LOS ANGELES

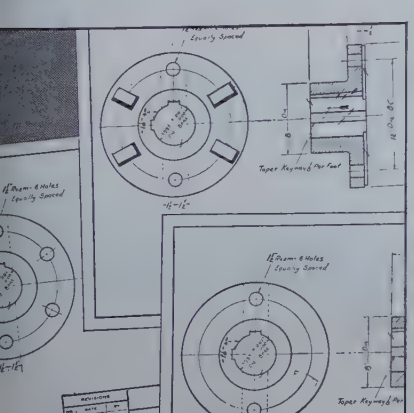
Dealers in Principal Cities

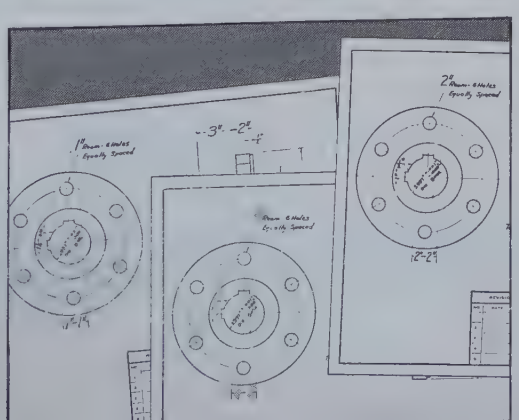
THESE SHORT CUTS WILL SAVE YOU TIME

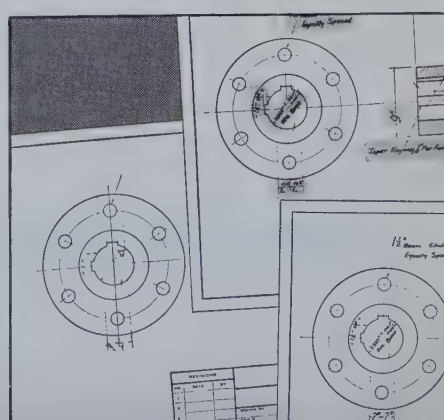
From this . . . to this WITH NO ERASURES! When a large element in your original drawing requires modifications, simply cut it out of the first Vapo-Vel print. Draw in the changes on a second Vapo-Vel print . . . and you have a new master.

Make quick corrections over scattered areas. When small patches of your original drawing need alterations, make a Vapo-Vel intermediate. Then eliminate the unwanted lines with POST Eradicator Fluid and redraw.

Add variable data with transparent matte tape. It is often economical to maintain standard drawings without dimensions and other variables, adding this information on transparent matte tape, as needed to specific orders. A subsequent Vapo-Vel print then supplies the completed drawing.







(CIRCUITS, *Cont. from page* 19)

photograph to produce an irregular and distorted conductor. If the tape is lifted, the remaining adhesive must be removed with solvent.

"One of the primary disadvantages of tape is that its raised surface produces shadows along the circuit path edges during photographing so that the resultant pattern has poor definition.

"A tape circuit layout should normally be considered an intermediate step in making the master layout. At completion, the tape layout should be immediately reproduced on dimensionally stable film and not reused unless carefully rechecked.

"Where tolerances are not a limiting factor, the intelligent use of tapes offers many time-saving advantages."

Photocircuits is investigating the production of circuit masters by the newer scribing method which employs a scribe-coated polyester film. With this system, the lands and circuit paths are outlined with scribed lines, and then through the medium of a photographic resist-coated peel coat, the circuit lines and pads are stripped out.

The manufacturing process complications that make it necessary to build in compensations on the master drawing are not familiar to many customers. For instance, when a finished circuit is to be electroplated with a copper solder or other metals, the conductor accepts the plating along the edges as well as on the top surface. It is quite possible that the plating may close up and bridge the circuit, or at least reduce spacing to the point where current leakage becomes a problem. Also, the plating build-up is greater on conductors that are isolated by some distance from other plated surfaces. When plated circuits are specified, the conductors are normally drawn same size, but more space is allowed between conductors.

One of the most common causes of variation in conductor width is overetching. In this case the etching solution will eat away the conductor under the edge of the acid-resist and reduce conductor width. In cases where it is important that a minimum conductor width be maintained, the master drawing should be made oversize to assure reliability.

It is preferred to have both spacing and line widths expressed as minimums. Be sure that the master is drawn to allow for plus 0.010″ on line width and spacing in critical areas. In other words, if 0.031″ is a design minimum on spacing, the master drawing must measure 0.041″ true size. If the minimum width of copper conductors is 0.020″ exclusive of nicks, add 0.010″ to give a total of 0.030″ for a true size measurement of line width on the drawing.

Very high tolerances can be achieved on printed circuitry, but always at increased cost. Drafting departments doing their own circuit masters should work closely with their suppliers and become aware of what can or cannot be done.

The procedures outlined here should give some insight on a few of the problems of making master circuit drawings. Actually, each circuit presents its own peculiar problems, the answers to which come only in the light of experience.

Smudge

"It doesn't say this new, automated equipment will replace you, Smudge, but merely that it will free you for more important work."

APPRAISING THE DRAFTING OPERATION

Set up measurable goals, then evaluate

by C. H. Bayer

TWO BASIC ELEMENTS are essential to the meaningful appraisal of the effectiveness of any function of an enterprise. First, measurable objectives must be established, and second, standards—against which the progress and accomplishment of the objectives can be measured—must be recognized and accepted by both the appraiser and the appraised.

The appraisal should be circumscribed by clearly stated objectives. If we don't know what we're attempting to measure or discover, it will be difficult if not impossible to arrive at meaningful conclusions. Attention should be focused on the relevant, on trends and on the future, for obviously one of the prime purposes of appraisal is to provide facts. These enable management to take appropriate action and to predict results, thus insuring the continous improvement and success of the function appraised.

It is important to differentiate between the purposes of a full-fledged periodic audit and the purposes of continuous self-appraisal. An audit comprises the examination of all phases of an operation. It is usually conducted by someone not directly associated with the day-to-day operations of the particular function. It may be requested by higher management because the practices and effectiveness of the operation are suspected to be under par, or it may be periodically conducted to insure that the operation is functioning at peak efficiency.

Continuous self-appraisal, on the other hand, is an essential part of the day by day functional program and should be the responsibility of the manager directly accountable for the work performed.

WORKING GOALS

IN DRAFTING, the following objectives may be established and their progress continuously measured:

- Improvement in the quality of drafting work.
- Increased volume of work.
- Improvement in scheduling work load and meeting schedule commitments.
- Improvement in the quality of products and/or services.
- Increased contribution of new ideas, patents, etc.
- Reduction of waste and spoilage due to drafting errors.
- Reduction of overtime costs while maintaining output levels.
- Elimination or reduction of subcontracted drafting work while maintaining output levels.
- Reduction of supervisory burden.
- Improved morale.
- Reduction of grievances.
- Reduction of absenteeism and labor turnover.

The standards against which the progress of established objectives can be measured will be influenced by the organization, products, services rendered, facilities and budgets. In the past, various criteria or "yardsticks" have been employed, but few if any of them have proven satisfactory in obtaining meaningful results.

Square footage of new drawings produced is obviously not acceptable, because effectiveness and related costs are not improved by arbitrarily increasing the size of the drawings produced. Drafting supervisors have been known to admit that if the yardstick of efficiency is to be square footage, they could arbitrarily increase the "efficiency" of their operation by issuing oversize drawings. The use of a square footage facto should be discouraged. A concen trated effort should be made to re duce drawing sizes and thus realiz cost savings which will naturall occur: a decrease in the material con sumed, simplified handling, and re duced mailing charges. Smaller draw ings are also more adaptable fo microfilming.

Number of drawings produced em braces the same inherent evils a square footage produced. It is pos sible to reduce the number of draw ings produced and at the same tim increase the effectiveness of a draftin operation. Careful planning, utiliza tion of existing drawings, tabulation and the addition of like parts to exist ing drawings will increase over-a output while reducing the number o new drawings.

Number of drawing revisions re quired is naturally but a single phas influencing over-all effectiveness. Th reduction or elimination of rewor due to errors will be a factor in in creasing output and reducing ex pense. In an efficient operation, th number of drawing changes will b kept at a minimum.

Ratio of the number of draftsme to engineers. In an expanding oper ation some measure of drafting effec tiveness can be recognized when th number of engineers required in creases in a greater proportion to tha of the number of draftsmen required However, consideration must be give to the reasons why engineers hav been added and where in engineerin operation they are employed. Usuall when the engineering force is in creased, it is to be expected that th requirements for draftsmen will als increase. Inversely when the numbe of engineers is decreased, it would b expected that the requirements fo

raftsmen would also decrease unless
ie drafting component takes on some
f the work previously done by en-
neers.

During the critical shortage of
ained and available new engineer-
g personnel, emphasis has been
laced upon keeping engineers em-
loyed at their highest skill. It follows
iat some previously assigned en-
ineering activities will be delegated
) drafting when such a program is
ctively adopted.

*Ratio of drafting salaries to orders
nd shipments.* A protracted analysis
f the ratio of drafting salaries to
roduct shipments, orders, and the
verage of both may prove useful in
lotting the trend of expenditures for
etting the drafting job done. For
ach given business or product line
ie dollars spent for drafting com-
ared with the business volume will
aturally vary. When the work per-
ormed is of the "custom-built vari-
ty" the drafting expenditure will
bviously be greater than when the
roduct is of a repetitive, standard
r multiproduction character.

Descending or ascending drafting
osts can be readily determined for
given operation by establishing and
iaintaining curves indicative of the
rends of both the business volume
nd the drafting charges. Increased
r decreased drafting effectiveness
an quickly be determined by analy-
is of the relationship of the two
urves.

*Ratio of the number of draftsmen
) all other employees.* In staffing a
iven operation, it is usually estab-
shed that there is a prescribed work-
ble balance of employees required
i various activities. This is normally
rrived at by a study of previous
imple operations combined with the
xperience and judgment of qualified
onsultants. It is reasonable to assume
iat the size of the business and the
ature and diversity of products or
ervices will predetermine the num-
er of draftsmen required in propor-
on to other employees. If it can be
roven by comparison that the event-
al drafting requirements of one busi-
ess are definitely less than the re-
uirements for an identical operation
lsewhere, it is obvious that the for-
ier is operating more efficiently.
here always exists the problem of
nding two or more operations which
re identical.

Evaluation for Improvement

In general, barring abnormal requirements, an effective, properly balanced drafting organization should be able to meet its commitments without resorting to overtime or subcontracted assistance. An operation which is consistently in hot water and behind schedules is either out of balance manpower-wise, is under-staffed or is not being properly supervised.

More recently it has been useful to consider the standards and procedures employed in a given operation. An operation which has implemented effective practices and standards and which constantly keeps abreast of new developments will perform more effectively than one which holds to outmoded, traditional practices. An experienced auditor can usually take a quick reading on the degree of effectiveness of one operation as compared with another by evaluating the practices which have been adopted by each. A given component will be no more effective than its practices allow.

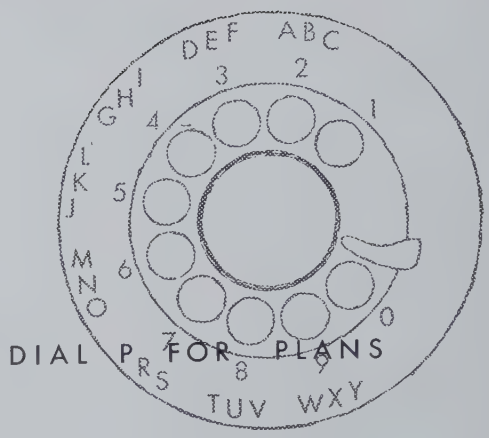
After appropriate objectives have been established and adequate measurement standards set forth, the conclusions drawn from the data gathered during a drafting operation appraisal may indicate:

Lack of leadership.
Poor planning and scheduling of work.
Inadequate controls.
Need for modernization of equipment and facilities.
Outmoded drafting practices.
Lack of integration with other functions of the enterprise.
Misunderstanding or lack of knowledge of corporation objectives.
Lack of effective communications.

No drafting operation can grow increasingly more effective unless its progress and results are continuously appraised against sound standards of performance. The future cannot be predicted unless we know where we stand today. The establishment of objectives and the application of proven measurements are "musts" in guiding management toward improved performance and profitable results.

The Author

Charles H. Bayer is Manager of Drafting Consulting Service, General Electric Co., Schenectady, N.Y.



DIALING A NUMBER locates an engineering drawing The dialing impulse activates a mechanism tha searches out the file drawer, hunts for the fil divider and then picks up the signalled aperture card t flash a microfilmed tracing over a closed circuit televisio system.

This technique of remote control filing, developed b General Precision Laboratory of Bedford, New York, an marketed by The Filmsort Company, of Pearl River, Ne York, division of Miehle-Goss-Dexter, Inc., marks anothe step in the engineer's and draftsman's progress in auto mating drawing reference and reproduction.

Once, a drawing was made for reproduction solely o whiteprint or blueprint machines. Today, drawings are re produced by methods that were unknown five years ag

Recently, a set of drawings was transmitted by facsimil between two points more than 150 miles apart. At th receiving station, the transmitted impulses were converte to an offset master from which several hundred distribu tion copies were made.

Much more common in many of the larger industri engineering organizations today is the use of electrostati printing known as xerography to reproduce drawing Here drawings in the form of aperture cards with micro filmed inserts are stacked into a hopper to print out hour as many as 600 prints, each 18 by 24 inches.

MORE EMPHASIS ON STANDARDS

THE EXPERIMENTS in transmission of drawings by tel vision and facsimile and the proved installations reproducing drawings from microfilm intermediates ha created a new set of problems for the chief draftsman.

Yesterday, drawings were made primarily for the blu print or whiteprint technique of reproduction. Toda drawings are reproduced half-size on offset masters; r duced 30 times on microfilm and then enlarged 15 tim on paper or reader screen; or copied by diazotype tec niques from one aperture card to the next.

Today, the chief draftsman supervises the creation drawings that may undergo up to seven photograph

Dialing

The New Way to Find a Drawing

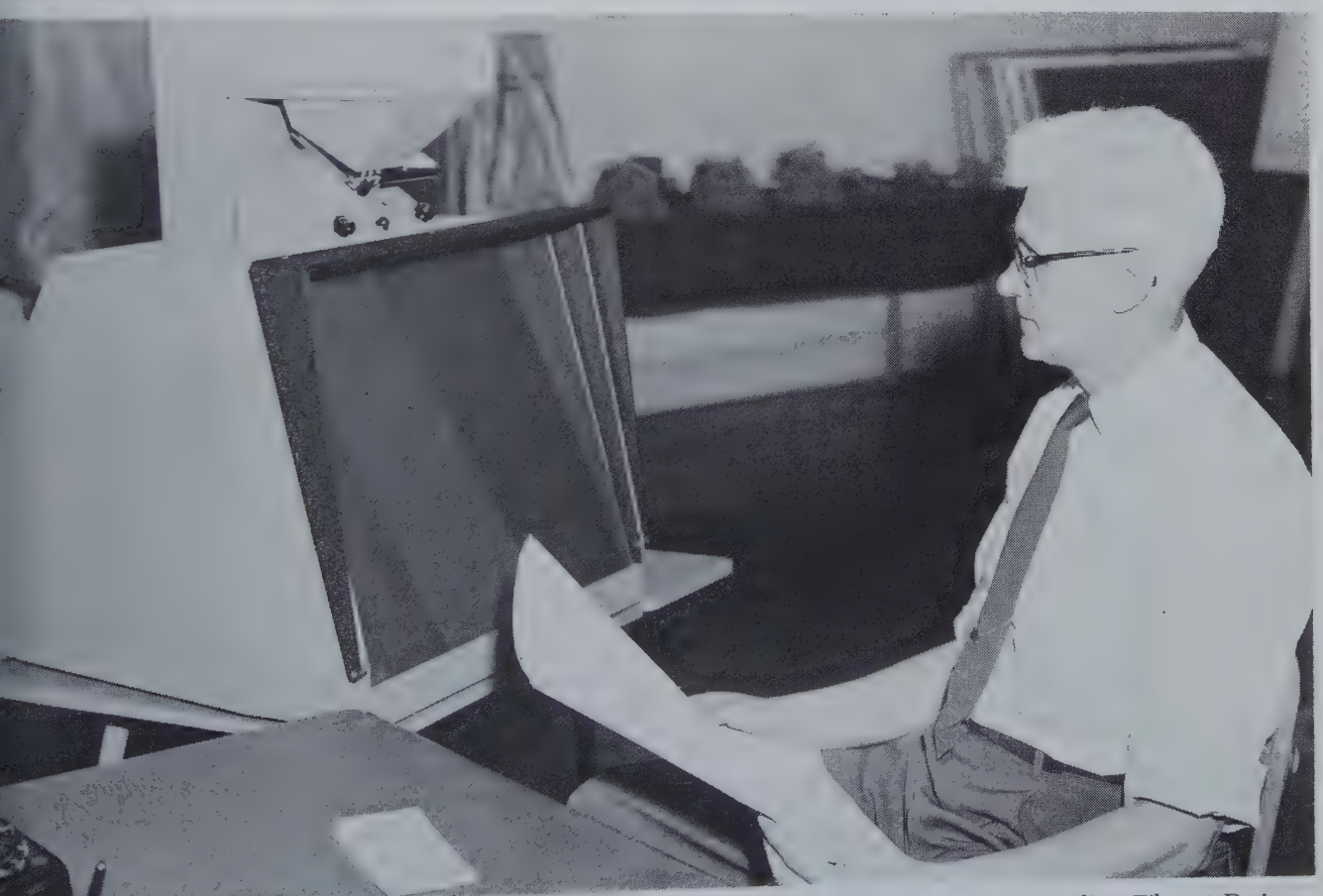
enerations in distribution before they are used to make a rint. Moreover, today's drawings will be reproduced in ocations far from the point of original drafting.

As a result of these methods of distribution and reproduction, one government agency has instructed its inspectors to tighten up on drafting standards in drawings ubmitted to the military agencies. Consequently, some overnment inspectors have started to look at a tracing ke a drafting supervisor.

This growing emphasis on drafting standards reflects the desire of both government and industry to get full value of the tracing in the new reproduction techniques.

In the remote control procedures, dialing is not the only technique for locating a tracing without clerical assistance. Instead of the dialing impulse, the file can be activated by punched or magnetic tape.

Consequently, the information for production scheduling obtained from the computer can in turn activate the



APERTURE card files, housed at point of use, allow reference without counter delay. Here, engineer utilizes Filmsort Designer.

DISPOSABLE copies of aperture cards are made on Uniprinte which contact-copies drawings onto diazo-type blank in card

remote control file to select the aperture cards of tracing with their up-to-date revisions. The selected tracings ca be reproduced by any of the standard methods now avail able.

This procedure of scheduling drawing reproduction lik any other production control operation should enable th reproduction supervisor to level out the peaks and valley of drawing reproduction.

In the reproduction department, there are usually tw types of drawing requests. The first is the scheduled typ for shop orders. Such requests can be automated an handled on a night shift by remote filing techniques.

The other type of drawing request is the impulse typ for engineering reference, parts orders, purchasing, etc The demand for this type of requisition is hard to predict

Many reproduction supervisors feel that impulse typ of requisitions are best handled by the standard filing pro cedures.

Moreover, the segregation between impulse and sched uled requests should provide better print service. Th reproduction supervisor, knowing what drawings are re quired for shop use, can fit such reproduction into hi scheduling.

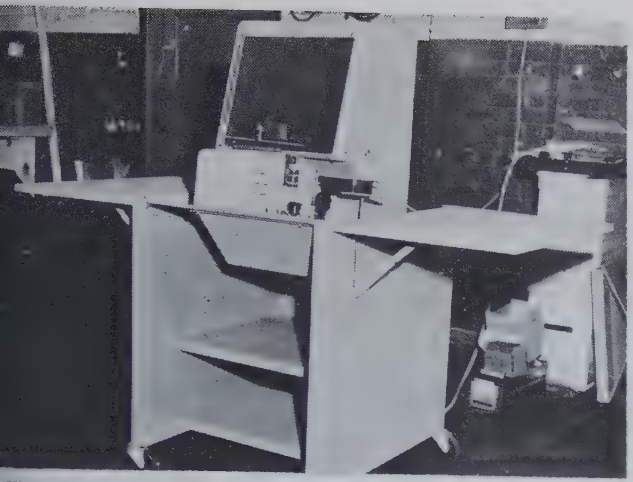
Therefore, with a certain percentage of the work loa scheduled for shop requirements, the reproduction super visor can concentrate on shortening the distribution cycl for the impulse type of requisitions.

Television, facsimile transmission, magnetic and punch tape retrieval are the new trends in drawing retrieval an reproduction. They are made possible because the admini strative engineering staff is converting the tracing inter mediate to a photo-mechanical medium.

Until recently, intermediates of tracings were at th best full- or half-sized duplicates of the original. As such tracings varied in size and because of this variation di not lend themselves to the mechanical methods of retrieva and reproduction.

For automatic handling, tracings had to be converte into a new medium. To provide such a photo-mechanica medium, microfilm and punch cards were combined into single aperture card.

In this process, the purpose of the microfilm is to reduc the tracing to a uniform size and to give the tracing uniform microfilm quality. The punch card is the carrie



MICROFILM and punch card are combined in semi-automatic mounter. Viewer screen verifies film and punch data matching.

f the microfilm. Punch card tests indicate remarkable owers for both automatic feeding and manual handling.

In the new technique, one of the major requirements is niform photographic quality. Much of the time lost in onventional operation of blueprint or whiteprint equipent is believed due to the judgment decisions made for eproducing individual tracings. With the upgraded photoraphic quality, many of the reproduction techniques used ith microfilm intermediates are performed at one exosure setting.

Consequently, the combination of a mechanical carrier ith uniform photographic quality of microfilmed tracings akes possible the new potentials in both television and acsimile transmission. There would be no practical value n being able to extract copies of engineering drawings uickly from the files unless they could be reproduced ith the identical ease.

As a result of these developments, two pressures are ound to ensue. One set of pressures will be on the draftsan; the other on the vendors.

To make the new system work, drafting specifications re of paramount importance. Two of the biggest headches are letters of less than minimum height and lines of arying density on the drawing. Thus, draftsmen can xpect supervisors to pay closer attention to the standards ook.

The other set of pressures will be on the vendors of he new system to increase the latitudes of the new engieering drawing reproduction techniques. Silver photogaphy has the widest latitude of the reproduction processes nown today.

The newer processes that work on dry principles can e operated in the daylight with great convenience. Neverheless, some of them do not have the wide band of sensivity found in the silver processes. Thus, the requirement to stretch sensitivity without sacrificing convenience.

All this effort by both draftsmen and vendors makes ossible the new era in engineering drawing reproduction hen television, facsimile, magnetic tape, and punched ape replace the bays of tracing files that held the full or alf-sized intermediates.

In the future, there won't be a line at the counter waitg for service. The biggest complaint may be dialing a rong number.

Graphic Perspective

by Eleanor W. Thompson

THE PRECISE ORIGINS of the draftsman are obscured by the passage of nearly 5000 years. However, it is clear that he springs from a long and distinguished lineage. His history is the history of civilization. His predecessors were the builders of ziggurats in Mesopotamia, of pyramids in Egypt, of monuments and temples in Greece and Rome. Ruins of ancient cities bear eloquent testimony to his work.

As for actual evidence of the existence of a figure called a draftsman, a statue of Gudea, petty ruler in Mesopotamia at about 2200 B.C., has been unearthed, showing him seated with drafting materials and a plan on his lap. The great Pyramid at Gizeh of Khufu, dating from the twenty-seventh century B.C., is evidence that the engineer-architects of Egypt possessed the skill necessary to measure distances and angles and to transfer a plan from a drawing to a site.

The Minoans built a palace at Cnossus sometime around 2100 B.C., with bathrooms, bathtubs and sanitary facilities flushed with water; they appear to be superior to any in Europe before A.D. 1800. It is probable that plans more specific than those which have come to us were made on parchment or papyrus long since crumbled into dust.

The Bible refers to Solomon's Temple "built of stone made ready before it was brought thither," suggesting that some form of graphics was used to indicate the sizes and shapes of these members. It is probable that the Greeks, builders of temples such as the Parthenon, had drawings of some sort to guide the stonecutters in shaping the structural elements and the workmen in assembling them. The Greeks had a word for the technician in charge of designing and building a structure—*architecton*. When the Romans took over Greek architectural forms and methods, they called their master technician or engineer *architectus*.

Projection Drawings

VITRUVIOUS was a Roman *architectus* whose treatise on architecture and engineering written in 30 B.C., refers to projection drawings for structures. Not until the early part of the fifteenth century, however, was the theory of projections known to be further developed. And it was near the end of the eighteenth century when Gaspard Monge, the French mathematician, advanced the theory of projection drawing to an academic study by introducing two planes of projection at right angles to each other. This provided the base for descriptive geometry, the science treating the graphical description of objects of three dimensions.

A historical picture painted wit strokes as broad and generous as th foregoing, lends itself to exaggera tion and generalities. Therefore w shall, in subsequent articles, examin more closely some of the fascinatin evidence of these early constructio and their authors. We shall, for ex ample, dip into the notebooks o Leonardo da Vinci, that left-hande titan of the sixteenth century who wa at one and the same time artist, arch tect, sculptor, aeronautical enginee and master draftsman. We shall mov from Roman structural techniques t the ribbed vault and flying buttresse of the medieval engineer in th eleventh century. We shall examin the draftsman as he was affected b the rise of modern science in th seventeenth century, the steam an industrial revolution of the eighteent century, the beginnings of applie science in the nineteenth century and in our own twentieth century, wha has been called the Age of Automati Control.

We shall, in short, attempt to brin into perspective the function of th draftsman in this highly specialize age—a function as complex and diver sified as the many branches of en gineering science to which it i applied.

References

Fletcher, Sir Banister: *A History o Architecture On The Comparativ Method*, 10th ed., Charles Scribner' Sons, New York; B. T. Batsford, Ltd London, 1938.

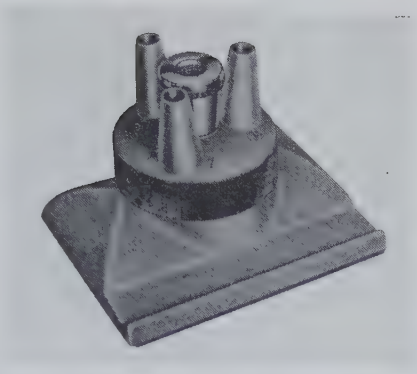
Gardner, Helen: *Art Through The Ages* 2nd ed., Harcourt Brace and Com pany, New York, 1936.

Giesecke, F. E., Mitchell, A., and Sper cer, H. C.: *Technical Drawing*, 2n ed., The Macmillan Company, Ne York, 1940.

Kirby, R., Withington, S., Darling, A. B and Kilgour, F. G.; *Engineering I History*, McGraw-Hill Book Company Inc., New York, Toronto, Londo 1956.

icrofilm Printer

Inexpensive dry-process duplicates less than one minute under ordiry room lighting are said to result om the use of a new technique. A evice called a Uniprinter, now in oduction at The Filmsort Comny's plant at Pearl River, N. Y. ivision of Miehle - Goss - Dexter, c.), is designed to process 35mm. lmsort Duplicards containing either nexposed Kalfax or diazo film. These ill be pre-mounted in apertures of y type of file or record card, from andard 3 by 5's or Remington Rand bulating (punch) cards. Use of the expensive dry - process duplicates ill mean master files remain intact d that distribution of work copies engineering drawings, research liary data and other records is simpli-ed. The Uniprinter is a manual-echanical unit about the size of a pewriter.



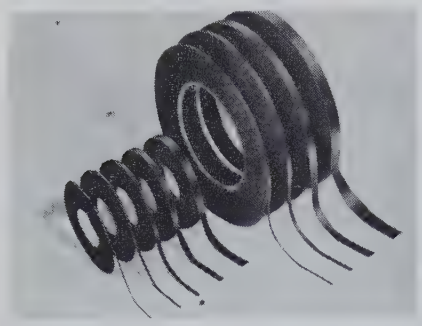
Pencil-Lead Pointer

Precision-built units, designed to give efficient service, point all grades of lead with a choice of three points: a sharp 4° point, a medium 7° point and a blunt 10° point. Called Tri-Pointer, it is manufactured by APSCO Products, Inc., P.O. Box 840, Beverly Hills, Calif. It has a free - turning turret-head and a weighted base; according to the manufacturer, it can be operated with one hand.

Moist Diazo Papers

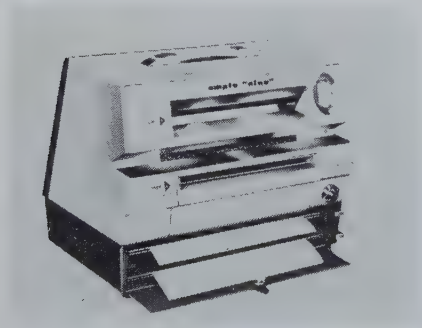
Two new semi-moist diazo papers provide high - quality, dense - line images at machine speeds faster than previously possible. The new papers, Onyx 5 and Onyx 8, were introduced recently by Keuffel & Esser Co., Adams and Third Sts., Hoboken, N. J. Onyx 5 is designed as a general purpose paper, which offers high-speed, quality reproductions of any good originals and most worn or low transparency originals. Onyx 8 is approximately 40 per cent faster than Onyx 5. Specifically, Onyx 8 is designed to permit reproduction from old yellowed drawings of sepia intermediates at very high speed, increase production on small equipment and permit reproduction of copy material which has low transparency. These papers are considered the first major developments in the moist diazo process field in 15 years.

New Products



Printed Circuit Tape

Narrow, precision-cut tapes, backed with clear, non-staining adhesive, are said to be especially suitable for use in making printed-circuit master layouts. Available in precision tolerance widths from 1/64-inch (0.015 inch) and up to any fraction of an inch in 15 and 60 yard rolls, the tape is made by By-Buk Co., 4314 W. Pico Blvd., Los Angeles 19, Calif. Use of this tape eliminates most of the time-consuming "filling-in" required to produce solid black conductor and terminal areas on master drawings; changes can also be quickly made without erasing when tape is used.



Multi-purpose Copier

The development of a new photocopier for engineering - reproduction department and office use, has been announced. Called the Ampto "Nine," the unit will handle papers and films up to nine inches wide by any length. Produced by Ampto, Inc., Newton, N. J. (subsidiary of Anken Chemical & Film Corp.), the unit weighs 18 pounds and is completely portable. The Ampto "Nine" can be used for straight diffusion transfer (peel-apart) exposures and processing, and with the new single sheet Planacopy process whereby unlimited copies can be made from a single negative.

Pocket Calculator

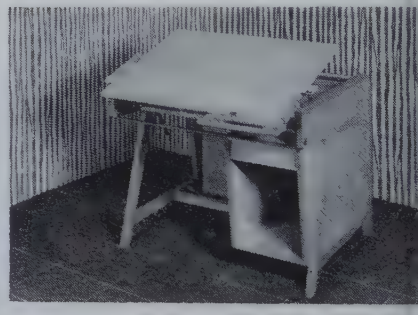
Shrinkage and draft calculators are said to save drafting time by reducing pencil calculations and by replacing scattered references such as handbooks, wall charts and manufacturers' catalogs. The handy unit is produced by Kelm Mfg. Co., Coloma, Mich. The front face shows shrinkage calculations from 0.003 inches per inch to 0.025 inches per inch and draft calculations from ½ degree to 30 degrees. The reverse side gives decimal equivalents of letter drills and of number drills, draft angle per side in degrees and a hardness conversion table of approximate values. The calculators are supplied with green plastic covers.

Hand Cutting Tools

Lightweight cutting tools with positive safety features have been developed for use where precision cutting, trimming or slicing is required. The replaceable-blade knives are the newest addition to the line of hand tools produced by X-acto, Inc., 48-41 Van Dam St., Long Island City 1, N. Y. Constructed of heavy-duty aluminum, each knife has a knurled sliding sleeve which may be locked at any position on the knife barrel. The sleeve can be moved back to reveal the knife blade completely, or locked to expose any segment of the blade. In the latter position, the adjustable sleeve serves as a depth gauge to limit the blade's cutting action. The knife's "safety-guard sleeve" may also be extended to cover the blade for safe carrying in shirt or jacket pocket. These knives are produced in two sizes: the slim handle (five inch) X-acto 1-G and the beaver handle (six and three-quarter inch) X - acto 2 - G for larger knife blades.

Drawing Ink Dispenser

An ink bottle in a non-skid rubbe base, equipped with a one-hand in dispenser, is said to speed up ink trac ing and drafting time by more tha 30 per cent. According to the manu facturer, the device is a time-save because it eliminates the need fo transferring instruments and stopper from hand to hand while filling. Calle Ink-A-Matic, it is available fro Higgins Ink Co., Brooklyn 15, N. Y



Desk-Drafting Table

A combination desk and draftin table, manufactured in Germany o European Beechwood, consists of plastics desk top which rolls back t free the drawer in which the drawin board rests. The board can be use flat or tilted to 70 degrees. The tabl top measures 37 by 28 inches, th desk is 30 inches high, and the draw ing board measures 37 by 26 inche A drafting machine can be added an stored with the board in the to drawer. There is additional drawe and storage space on the lower righ Introduced by Grammercy Guil Group, Inc., 116 Broad St., New Yor 4, N. Y., the multi-purpose unit said to be ideal for schools since allows drawing furniture to be use for other purposes.

New Literature

me-Saving Tips, a booklet for the aftsman and engineer, presents 59 afting shortcuts, each clearly illus-ated. The booklet may be obtained thout charge from Frederick Post ., 3650 North Avondale Ave., Chi-go 18, Ill.

notocopying Brochure, P544, de-ribing the two newest numbers of e Transcopy Photocopier line, may obtained from Remington Rand, vision of Sperry Rand Corp., 315 urth Ave., New York 10, N. Y. The ochure introduces the 9½-inch wide anscopy Star and the 15-inch de Transcopy Mercury.

egative File Catalog No. 24, show-g efficient filing devices for nega-es, film strips, microfilm, lantern des, reels and projectors, movie film, reo slides, magazines, Kodak gela-e filter frames and other special uipment, is available without arge from The Nega-File Co., Box 5, Doylestown, Pa. All items are early illustrated. Prices are included.

talog and Reference Chart for aftsmen, architects, engineers, de-ners, etc., is offered without charge Alvin and Co., Inc., 611 Palisado e., Windsor, Conn. The catalog is ly illustrated and shows a complete e of drawing materials and equip-nt. It contains a number of refer-ce charts, such as fraction-decimal uivalents, tap drill sizes and nut, lt, wire, cap and screw specifica-ns.

Transparentizing Method Bulletin, describing the CTS transparentizing method and its uses in the blueprint room, engineering and reproduction department, may be obtained from Hampton Processes, Inc., Newton, N. J. The bulletin, prepared as a guide to all types of reproduction departments, consists of a number of articles and case histories discussing new techniques in transparentizing, cleaning and sealing drawings, documents and "stats."

Electronic Symbol Catalog, No. E58, describing a complete system of pre-printed, adhesive-backed electronic symbols for use on engineering drawings, may be obtained without obligation from Tech-Tac, Inc., 727 West 7th St., Los Angeles 17, Calif. These symbols, compatible with Specification MIL-STD-15, Electrical and Electronic Symbols, are printed on thin acetate sheet. The catalog shows a number of symbols actual size and gives information for ordering, filing, using and storing.

Technical Publications Facilities are outlined in a brochure prepared by the Technical Publications and Reports Department of Burns and Roe, Inc., 160 West Broadway, New York 13, New York. Described as a "specialized publications group" the department can produce handbooks, reports, manuals, surveys, and brochures, slides, graphs, and charts. Among the Department's clients have been the U.S. Navy's Bureau of Yards and Docks, and U.S. Army Corps of Engineers.

ASA DRAFTING STANDARDS

A Report

UNIFORM DRAFTING PRACTICES in the United States were given substantial encouragment in October 1957 when the American Society of Engineering Education, the American Standards Association, and The American Society of Mechanical Engineers jointly announced the first four sections of the American Drafting Standards Manual, approved by the ASA and published by ASME.

The project, first started in 1925, has been actively pursued since 1948, and when completed will result in a 17-section Standard. Sections are available separately. The practices laid down in the American manual are coordinated with standard practices in Great Britain and Canada, so that, it is expected, drawings made in one of the English-speaking countries will be readily understood in the others.

The Manual is being prepared under the supervision of Sectional Committee Y14 of the ASA. Listed below are descriptions of those Sections currently available: 1 through 7, 9, 10, 11, and 17.

The remaining sections, covering drafting standards for Castings, Die Castings, Helical and Flat Springs, Structural Drafting, Electrical Diagrams, and Tools, Dies and Gages, are expected to be completed and published during 1960.

Section 1: Size and Format (ASA Y14.1–1957). 12 pp. $1.00. Prepared under the chairmanship of A. H. Rau, General Electric Company, Schenectady, N. Y., Y14— deals with sheet sizes, border lines, title blocks, and the like.

Section 2: Line Conventions, Sectioning and Lettering (ASA Y14.2–1957). 20 pp. $1.50. Henry C. Spencer was chairman of the subcommittee responsible for this section, covering an area on which nationwide agreement is apparently well established. Professor Spencer is Head of the Department of Technical Drawing, Illinois Institute of Technology.

Section 3: Projections (ASA Y14.3–1957). 12 pp. $1.50. C. J. Vierck, Professor of Engineering Drawing, The Ohio State University, headed a six-man subcommittee in the development of this section which covers the arrangement of views for multiple view orthographic projections.

Section 4: Pictorial Drawing (ASA Y14.4–1957). 20 pp. $1.50. This section, prepared under the direction of C. E. Springer, Professor of General Engineering, University of Illinois, delineates correct nomenclature for various kinds of pictorial drawings including isometric, dimetric, trimetric, oblique projections, and the various forms of perspective drawings.

Section 5: Dimensioning and Notes (ASA Y14.5–1957). 40 pp. $2.00. A 17-man subcommittee headed by Norman E. Brown, Chief Design Engineer, The Taft-Pierce Mfg. Co., Woonsocket, R. I., was responsible for this long section, described by Professor Hoelscher, Y14 Committee chairman at the time of its publication, as "the most controversial in the entire drafting standards program."

According to Hoelscher, in an article in ASA's publ

(*Continued on page* 37)

his is the Questionnaire referred in the editorial on page 36.

GRAPHIC SCIENCE IS FOR SOME—NOT ALL

IN ORDER to receive subsequent copies of GRAPHIC SCIENCE, the Questionnaire below must be completed and returned to: Editor, GRAPHIC SCIENCE, 103 Park Avenue, New York 17, New York. A facsimile can be filled out and mailed if you would like to keep this first issue intact. All Questionnaires will be acknowledged.

Your free subscription to GRAPHIC SCIENCE will be continued if your job involves: (1) The supervision of draftsmen or a drafting department. (2) Supervision of reproduction or drawing-filing personnel or departments. (3) Supervision of technical illustrators or technical photographers. (4) Teaching of engineering drawing or graphics. If you do not qualify and wish to continue receiving GRAPHIC SCIENCE, the subscription rate is $8.00 per year in the United States, $9.00 per year to Canada; $10.00 to other countries.

Your free subscription will be discontinued if the questions below are not answered. The information you supply here will never be divulged. In coming issues, however, we will summarize the data received, reporting results for your own information.

May we hear from you shortly?

Name: _____

Title: _____

Company: _____

Address: _____

_____

_____

Company Product or Function: _____

_____

_____

Your job function: _____

_____

_____

_____

Number of personnel in your department:

_____ Draftsmen _____ Reproduction

_____ Designers _____ Checkers

_____ Technical Illustrators _____ Others

I've been working in my present job for _____ years.

Check one:

_____ I'm qualified to receive GRAPHIC SCIENCE free. Continue my subscription.

_____ Take me off your list.

_____ I don't think I'm qualified to receive GRAPHIC SCIENCE free, but I'd like to subscribe.
_____ Bill me. _____ Check enclosed.

There are other personnel in my firm who should receive GRAPHIC SCIENCE. Their names, titles, and addresses are as follows:

_____

_____

_____

_____

(You may attach a second sheet, if the space here is not adequate.)

Comments? _____

_____

I'm interested in writing for GRAPHIC SCIENCE:

_____ Yes _____ No

Signed _____

A Magazine Called Graphic Science

VOLUME ONE, NUMBER ONE, which you now hold in your hands, is the fruition of an idea conceived a handful of years ago: a magazine for the supervisor of drafting, reproduction, and technical illustration. The extraordinary developments taking place within these three areas make the challenge before us—as a new publication—one of exciting proportions. It far exceeds the visions we first had.

For you, these technological and organizational changes are bringing about new opportunities and new problems. In coming issues we'll touch on both.

A DRAFTING ROOM SUPERVISOR with whom we spoke the other day—and who shall remain nameless here—described himself as "one of the forgotten men." Was he speaking for a great many chief draftsmen, graphics supervisors, and teachers of engineering graphics and drawing?

National spotlights have been turned on the engineer and scientist in recent years. But who ever heard of a drafting department—in public?

The entire area of drafting and of technical graphics has been described as a dark cave into which very little light has ever been thrown. For instance:

How many draftsmen are there in this country? We have heard estimates ranging from 150,000 to 600,000.

What is the ratio of draftsmen to engineers in this country? Is there really a shortage of draftsmen? Is part of the success of Russia's technological growth over the past years accounted for by the fact that a Russian engineer has perhaps twice as many draftsmen and engineering aids working with him as does his American counterpart?

Top draftsmen and professors of engineering drawing are concerned that engineering students are being exposed to less and less actual drawing experience in college. What effect is this having on the operation of your drafting department?

These are the questions which over the coming months GRAPHIC SCIENCE will explore.

THE BEST EDITOR, in my opinion, is one who brings interesting, accurate, timely and useful material to his readers. It is also my opinion that readers are primarily people, even when they're browsing through a technical publication on the job, or studying the sports section; they are readers who are interested not only in their own particular work, and in doing it well, but also interested in people around them doing similar jobs, interested in the world of politics, and of economics, and in the small bits of humor that get hung on the wall to get laughed at.

Smudge, we trust, is here to stay. We'll try to keep GRAPHIC SCIENCE comprehensive in its coverage of the field, factually flawless, and readable and personable as well.

IN COMING ISSUES watch for articles on the chief draftsman—as supervisor, for articles on new techniques in handling drawings, for profiles of leading men in the field, for articles on contemporary drafting room design, for in-plant reports of drafting operations in all kinds of industries, for articles giving practical suggestions that can save your department time and money.

Look for news of product and materials developments, for reviews of new books, bulletins, and catalogs, look for articles on microfilming and storage systems.

But that's only the beginning, as is this issue. There's only one requirement to receive subsequent ones: It is necessary that the questionnaire on page 35 be filled out immediately and forwarded to us. The information you supply will never be divulged, but it will help us make GRAPHIC SCIENCE a publication of maximum usefulness to you.

The Staff

INTRODUCTIONS are in order: Assistant Editor Eleanor W. Thompson, formerly aeronautical draftsman and technical illustrator, has been editor and writer for numerous projects and publications, including technical handbooks, and magazines, prior to joining our staff. Her column, Graphic Perspective, will appear each month.

Associate Editor Jay H. Bergen, Director of the Engineering Services Laboratory, American Machine and Foundry Co., has been active in the fields of graphics, drafting and engineering for 25 years. While responsible for the operation and performance of four engineering service departments at AMF: Standards, Drafting Processes, Technical Information, and Process Analysis, he has found time to write numerous articles and papers including "Simplified Drafting."

Associate Editor Wilfred J. Thompson, architect, and former architectural draftsman, illustrator, and project director of technical publications for Navy Aircraft, is designer and project manager at McKim, Mead and White.

Associate Editor Irwin Wladaver, Associate Professor of Engineering Drawing, College of Engineering, New York University, has been editor, American Society for Engineering Education, Division of Engineering Graphics publication, *Journal of Engineering Graphics*. Currently vice chairman, and Chairman-designate of this Division for 1960-61, he is author or co-author of five books in the field of drafting and engineering graphics. He is represented in this issue by the article, "Draftsmen, Where to from Here?"

(*STANDARDS, Continued from page* 34)

cation, "The Magazine of Standards" in October 1957, the areas of difficulty were confined to three topics, relatively new in American drafting practice: "1. Tolerancing of form, or 'geometric tolerancing' as it is called in the British Standard. 2. True position tolerancing. 3. The application of the maximum material concept in dimensioning drawings."

Section 6: Screw Threads (ASA Y14.6–1957). 20 pp. $1.50. Prepared under the direction of Professor W. J. Luzadder, Purdue University, this section includes Thread Representation, Thread Series and Thread Classes, Thread Selection, Thread Specification and Thread Dimensioning.

Section 7: Gears, Splines and Serrations (ASA Y14.7–1958). 20 pp. $1.50. To show standard methods for detailing gears, particularly the teeth, to define the basic minimum drawing information for the manufacture and inspection of gears, and to indicate optional information frequently required for a more specific definition of process control or product quality, are the purposes of this section, prepared under the direction of subcommittee chairman, H. H. Gotberg, Vice President and Chief Engineer, Colonial Broach Co., Detroit.

Section 8: Castings. In preparation.

Section 9: Forgings (ASA Y14.9–1958). 16 pp. $1.50. Charles M. McMahon, Chief Draftsman, Bay State Abrasive Products Company, Westboro, Mass., was chairman of the subcommittee responsible for this section which covers draft, parting planes, thickness of webs, fillets, radii, and the like.

Section 10: Metal Stampings (ASA Y14.10–1959). 24 pp. $1.50. A. R. Coleman, Western Electric Co., Chicago, Ill., was chairman of the group which prepared Section 10, purpose of which is "to indicate basic empirical layout and drafting practices specifically related to metal stampings. . . . The contents cover practices commonly used by small parts manufacturers in the production of metal stamping as produced on standard types of punch presses."

Section 11: Plastics (ASA Y14.11–1958). 24 pp. $1.50. Chairman of subcommittee 11 was H. E. Minneman, Delco-Remy Div., General Motors Corp., Anderson, Ind. In addition to including a brief discussion of materials and manufacturing processes and operations, this section indicates preferred design and designing practices.

Section 12: Die Castings. In preparation.

Section 13: Springs, Helical and Flat. In preparation.

Section 14: Structural Drafting. In preparation.

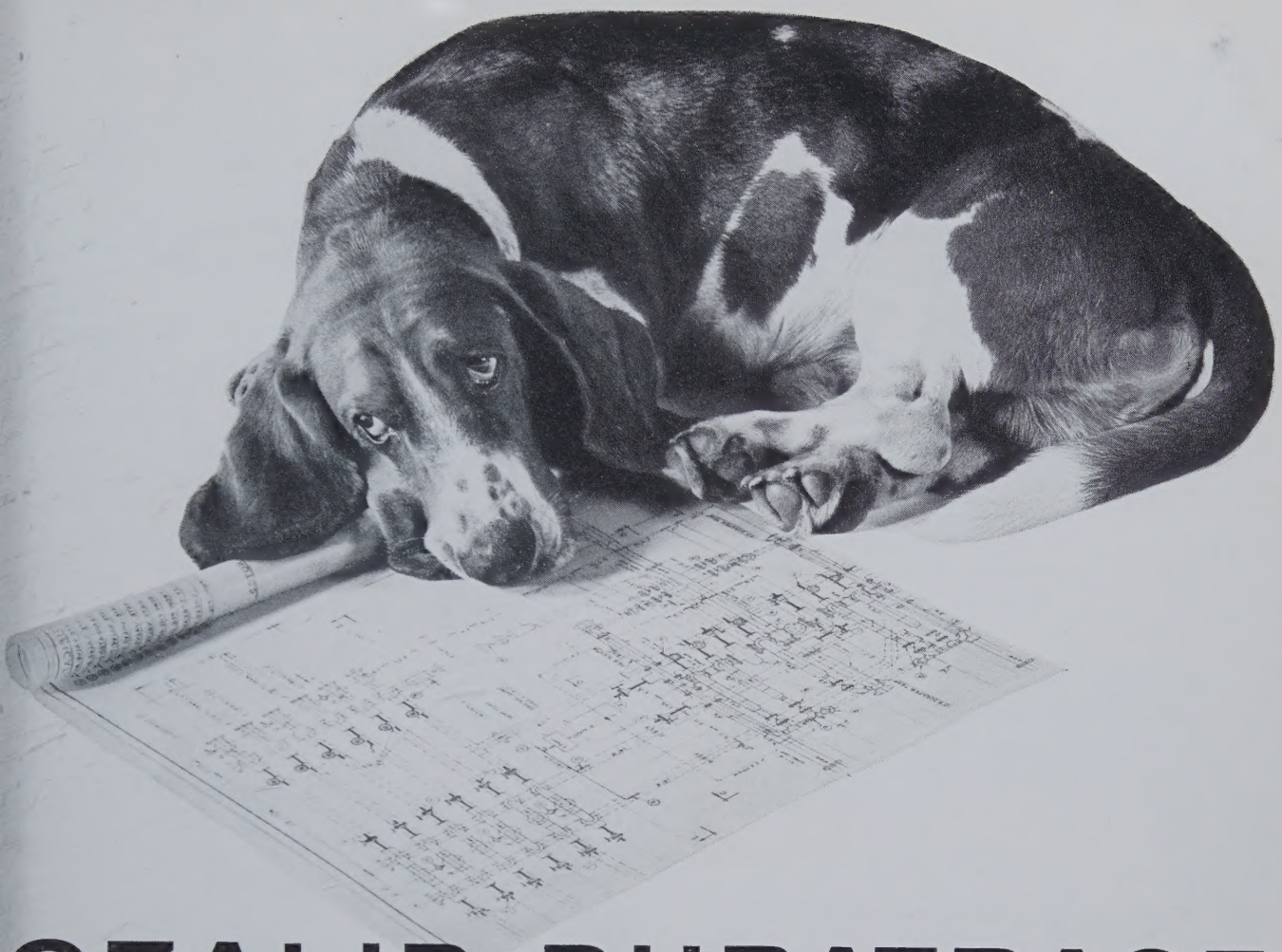
Section 15: Electrical Diagrams. In preparation.

Section 16: Tools, Dies and Gages. In preparation.

Section 17: Fluid Power Diagrams (ASA Y14.17–1959). 28 pp. $1.50. A unit headed by K. Court, Vickers, Inc., Detroit, Michigan, developed this section of the American Drafting Standards Manual, which comprises a series of procedures to be followed in the delineation of fluid power systems drawings.

In addition to the American Drafting Standards Manual, listed above, ASME has published other ASA standards of interest to the draftsman, or technical illustrator including Graphical Symbols, Letter Symbols, Illustrations for Publication and Projection, and Abbreviations for Use on Drawings. Copies of these and the Y14 Sections published to date are available from the ASA, 70 East 45th St., New York 17, N. Y. or from ASME, 29 West 39th St., New York 18, N. Y.

Advertisers Index



OZALID DURATRACE

is tearproof, bruise-resistant, and — won't "dog-ear"

Virtually tearproof! As its name implies, Duratrace is an extremely durable drafting film, far superior to cloth—and less costly. Its base is Mylar* polyester film, the toughest film ever made. Duratrace won't tear, "dog-ear" or bruise under handling . . . maintains its high-dimensional stability under any climatic condition.

Easier corrections! The fine-tooth, fibre-free matte surface of Duratrace takes pencil better than cloth—permits *hard* pencils for greater accuracy. It can take 15 pencil erasures in one spot *without "ghosting."*

Better, faster reproduction! The extra-high translucency of Duratrace means maximum-contrast prints—*faster*. Distortion of drawings is ended, for it won't stretch, melt or peel in copying machines.

* ®Du Pont polyester film

OZALID

Division of General Aniline & Film Corporation
In Canada: Hughes-Owens Co., Ltd., Montreal

MAIL TODAY
FOR FREE
TEST SAMPLE!

OZALID, Dept. VV-10
Johnson City, New York

Please send me free test sample and descriptive brochure on Ozalid Duratrace.

Name_____

Company_____

Position_____

Street_____

City_____

Zone_____ State_____

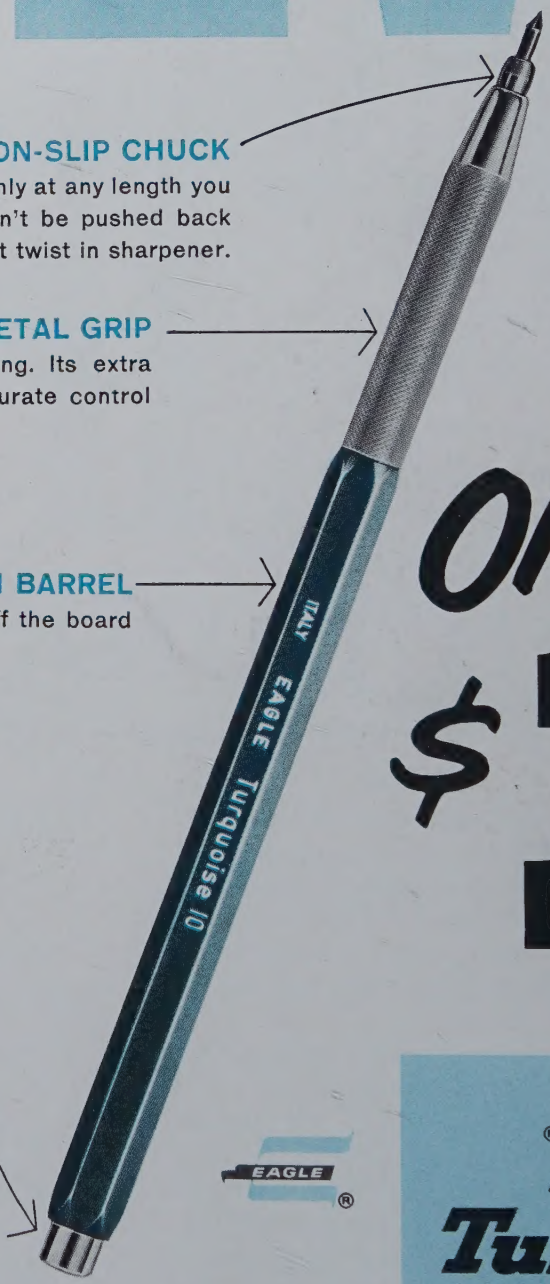
NEW!

This Eagle Turquoise Lifetime 1 lead holder with all these extra features . . .

NEW NON-SLIP CHUCK
holds lead firmly at any length you want. Lead can't be pushed back in barrel, won't twist in sharpener.

NEW SATIN FINISH METAL GRIP
is knurled for easier holding. Its extra length gives you more accurate control with less finger tension.

NEW ANODIZED ALUMINUM BARREL
is unbreakable. And it can't roll off the board because it's hexagon-shaped.



NEW PUSH BUTTON
instantly releases the chuck's grip on the lead at the touch of the thumb. It's colored for quick identification of grade.

ONLY $1.00

All-metal construction makes it the buy of a lifetime.

EAGLE PENCIL COMPANY, DANBURY, CONN.
NEW YORK • LONDON • TORONTO • MEXICO • SYDNEY • BOGOTA

®Eagle Turquoise

PENCILS, LEADS AND HOLDERS

are the largest-selling in the United States.